PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 09 October 2000 (09.10.00)	
International application No. PCT/US00/01499	**Applicant's or agent's file reference** BEN020345PCT
International filing date (day/month/year) 21 January 2000 (21.01.00)	**Priority date** (day/month/year) 22 January 1999 (22.01.99)
Applicant BIEL, John, P., Jr. et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

16 August 2000 (16.08.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer R. Forax
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

WO 00/43105
PCT/US00/01499

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:
CARRIER, Robert, J.
Price, Heneveld, Cooper, DeWitt & Litton
695 Kenmoor, S.E.
P.O. Box 2567
Grand Rapids, MI 49501
ETATS-UNIS D'AMERIQUE

RECEIVED
AUG 07 2000
PRICE, HENEVELD, COOPER, DEWITT & LITTON
PER Robert J. Carrier

Date of mailing (day/month/year) 27 July 2000 (27.07.00)	
Applicant's or agent's file reference BEN020345PCT	**IMPORTANT NOTICE**
International application No. PCT/US00/01499	**International filing date** (day/month/year) 21 January 2000 (21.01.00)
Priority date (day/month/year) 22 January 1999 (22.01.99)	
Applicant BENTELER AUTOMOTIVE CORPORATION et al	

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AU,JP,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CR,CU,CZ,DE,DK,DM,EA,EE,EP,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   27 July 2000 (27.07.00) under No. WO 00/43105

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, **a demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/01499

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :B01D 53/34, 53/88, 53/92, 53/94
US CL :422/177, 179, 180; 60/299
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 422/177, 179, 180; 60/299, 300

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST
Search terms: catalytic converter, vacuum, insulation, shield, bellow

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,795,615 A (CYRON et al) 03 January 1989, see entire document.	1-24
Y	US 5,380,501 A (HITACHI et al) 10 January 1995, see entire document.	1-24
Y	US 5,419,876 A (USUI et al) 30 May 1995, see entire document.	1-24
Y	US 5,477,676 A (BENSON et al) 26 December 1995, see entire document.	1-24

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
10 APRIL 2000

Date of mailing of the international search report
18 APR 2000

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3230

Authorized officer
HIEN TRAN
Telephone No. (703) 308-0661

Form PCT/ISA/210 (second sheet) (July 1998)*

19

REPLACED BY ART 34 AMDT

PATENT COOPERATION TREATY

PCT

REC'D 20 MAR 2001

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference BEN020345PCT	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US00/01499	International filing date *(day/month/year)* 21 JANUARY 2000	Priority date *(day/month/year)* 22 JANUARY 1999
International Patent Classification (IPC) or national classification and IPC IPC(7): B01D 53/34, 53/88, 53/92, 53/94 and US Cl.: 422/177, 179, 180; 60/299		
Applicant BENTELER AUTOMOTIVE CORPORATION		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 34 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
16 AUGUST 2000	12 FEBRUARY 2001
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer B. Hien Tran HIEN TRAN
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0661

Form PCT/IPEA/409 (cover sheet) (July 1998)*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US00/01499

I. Basis of the report

1. With regard to the elements of the international application:*

[ ] the international application as originally filed

[X] the description:
pages (See Attached) , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

[X] the claims:
pages (See Attached) , as originally filed
pages _____ , as amended (together with any statement) under Article 19
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

[X] the drawings:
pages (See Attached) , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

[X] the sequence listing part of the description:
pages (See Attached) , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

[ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

[ ] the language of publication of the international application (under Rule 48.3(b)).

[ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

[ ] contained in the international application in printed form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readable form.

[ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] The statement that the information recorded in computer readable form is identical to the writen sequence listing has been furnished.

4. [X] The amendments have resulted in the cancellation of:

[X] the description, pages NONE

[X] the claims, Nos. NONE

[X] the drawings, sheets~~fig~~ NONE

5. [ ] This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US00/01499

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. statement

Novelty (N)	Claims	3, 5, 6-12, 14-15, 17-23	YES
	Claims	1-2, 4, 13, 16	NO
Inventive Step (IS)	Claims	6, 10, 15, 17-23	YES
	Claims	1-5, 7-9, 11-14, 16	NO
Industrial Applicability (IA)	Claims	1-23	YES
	Claims	NONE	NO

2. citations and explanations (Rule 70.7)

Claims 1-2, 4, 13, 16 lack novelty under PCT Article 33(2) as being anticipated by Hitachi et al (5,380,501).

Hitachi et al disclose an exhaust treatment device comprising:

an inner housing 21 containing a thermally-activated exhaust treatment device 1 therein;

an outer housing 22 enclosing the inner housing 21 but not contacting the inner housing 21; the inner and outer housings 21, 22 including walls forming a sealed cavity around the inner housing; the cavity having a vacuum drawn therein (col. 4, lines 67-68; col. 5, lines 1-2); and

a support including a plurality of spokes 26 that extend radially between the inner and outer housings 21, 22.

Instant claims 1-2, 4, 13, 16 structurally read on the apparatus of Hitachi et al.

Claims 3, 7, 8, 14 lack an inventive step under PCT Article 33(3) as being obvious over Hitachi et al (5,380,501) or Cyron et al (4,795,615).

With respect to the specific material of the spokes, it would have been obvious to one having ordinary skill in the art at the time the invention was made to select an appropriate material for the spokes to achieve the desired benefit attendant therewith and since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice.

With respect to the specific dimension or shape of the spokes, it would have been obvious to one having ordinary skill in the art at the time the invention was made to select an appropriate dimension or shape for the spokes to achieve the desired benefit attendant therewith on the basis of its suitability for the intended use as a matter of obvious design choice and since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges or shapes involves only routine skill in the art.

(Continued on Supplemental Sheet.)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US00/01499

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claims 18-22 are objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 6 because the claims are indefinite for the following reason(s):

In claim 18, line 1 "the feet" has no clear antecedent basis; in line 2 it is unclear as to what "composite" is implied and where it is disclosed in the instant disclosure. See claims 19-22 likewise.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US00/01499

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII Sheet 10

I. BASIS OF REPORT:

This report has been drawn on the basis of the description,
page(s) 1-3, 5-6, 8, 16-18, 20, 22, 24, as originally filed.
page(s) NONE, filed with the demand.
and additional amendments:
Pages 4, 7, 9-15, 19, 21, 23, filed with the letter of 12 January 2001.

This report has been drawn on the basis of the claims,
page(s) NONE, as originally filed.
page(s) NONE, as amended under Article 19.
page(s) NONE, filed with the demand.
and additional amendments:
Pages 25-28, filed with the letter of 12 January 2001.

This report has been drawn on the basis of the drawings,
page(s) NONE, as originally filed.
page(s) NONE, filed with the demand.
and additional amendments:
Pages 1-18, filed with the letter of 12 January 2001.

This report has been drawn on the basis of the sequence listing part of the description:
page(s) NONE, as originally filed.
pages(s) NONE, filed with the demand.
and additional amendments:
NONE

V. 2. REASONED STATEMENTS - CITATIONS AND EXPLANATIONS (Continued):
Claims 11-12 lack an inventive step under PCT Article 33(3) as being obvious over Hitachi et al (5,380,501) in view of Cyron et al (4,795,615).

Cyron et al disclose provision of a support for supporting the inner housing 1 in the outer housing, the support including a radially extending body 4b and including a foot 7 that slidable engages at least one of the inner and outer housings 1, 2.

It would have been obvious to one having ordinary skill in the art to construct the spokes of Hitachi et al so as they would slidable engage at least one of the inner and outer housings to reduce the thermal stress as taught by Cyron et al.

Claims 1-2, 4, 5, 9, 12-13 lack an inventive step under PCT Article 33(3) as being obvious over Cyron et al (4,795,615) in view of Hitachi et al (5,380,501).

With respect to claim 11, Cyron et al disclose an exhaust treatment device comprising:

an inner housing 1 containing a thermally-activated exhaust treatment device therein;

an outer housing 2 enclosing the inner housing 1 but not contacting the inner housing 1; the inner and outer housings 1, 2 including walls forming a sealed cavity around the inner; and

a support for supporting the inner housing 1 in the outer housing, the support including a radially extending body 4b and including a foot 7 that slidably engages at least one of the inner and outer housings 1, 2; the foot including an insulative material, i.e. wire mesh 10.

The apparatus of Cyron et al is substantially the same as that instantly claimed, but fails to disclose whether the cavity may have a vacuum drawn therein.

However, Hitachi et al disclose provision of a cavity having a vacuum drawn therein.

It would have been obvious to one having ordinary skill in the art to draw a vacuum in the cavity of Cyron et al to improve the heat insulating effect for the casings as taught by Hitachi et al.

With respect to claims 1-2, 4, 5, 9, 12-13, Cyron et al further disclose that the support may include a plurality of spokes, i.e. wire meshes 10 that extend radially between the inner and outer housings 1, 2.

Claims 6, 10, 15, 17-23 meet the criteria set out in PCT Article 33(2)-(3), because the prior art of record does not teach the exhaust treatment device having the specific supports as claimed.
Claims 1-23 meet the criteria set out in PCT Article 33(4), because they are directed to an exhaust treatment device for a vehicle.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US00/01499

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

Sheet 11

Applicant's arguments filed 12 January 2001 have been considered but they are not persuasive.

Applicant argues that the composite in claim 21 can be a combination or wire and ceramic or other combination. Such contention is not persuasive as there is no support for such contention.

Applicant argues that Hitachi does not disclose spokes extending between the inner and outer housings. The item 26 is called "linear partition walls" that extend parallel to the axis of the core body. Such contention is not persuasive as the fact that the supports in Hitachi extend parallel to the axis of the core body does not change the fact that they also extend radially between the inner and outer housings which meet the requirement of the instant claim.

Applicant argues that Cyron does not disclose spokes. Such contention is not persuasive as Cyron discloses that the support may include a plurality of spokes, i.e. wire meshes 10 that extend radially between the inner and outer housings 1, 2.

---------- NEW CITATIONS ----------

NONE

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B01D 53/34, 53/88, 53/92, 53/94 — A1

(11) International Publication Number: **WO 00/43105**

(43) International Publication Date: 27 July 2000 (27.07.00)

(21) International Application Number: PCT/US00/01499

(22) International Filing Date: 21 January 2000 (21.01.00)

(30) Priority Data:
60/116,828 22 January 1999 (22.01.99) US

(71) Applicant *(for all designated States except US)*: BENTELER AUTOMOTIVE CORPORATION [US/US]; Suite 500, 50 Monroe Avenue, N.W., Grand Rapids, MI 49503-2656 (US).

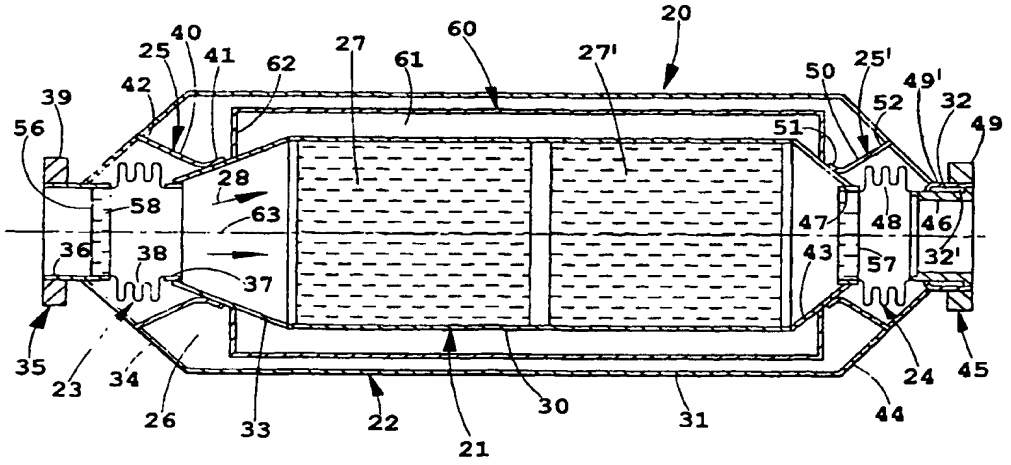
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: BIEL, John, P., Jr. [US/US]; 2433 Belknap Avenue, N.E., Grand Rapids, MI 49505 (US). HILL, Frederick, B., Jr. [US/US]; 6748 Knollcrest, Rockford, MI 49341 (US). MEWS, Lance [US/US]; 4640 6th Street, Caledonia, MI 49316 (US). RIGSBY, Donald, R. [US/US]; 1923 Mulberry Lane, Jenison, MI 49428 (US).

(74) Agent: CARRIER, Robert, J.; Price, Heneveld, Cooper, De Witt & Litton, 695 Kenmoor, S.E., P.O. Box 2567, Grand Rapids, MI 49501 (US).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: VACUUM-INSULATED EXHAUST TREATMENT DEVICES WITH RADIALLY-EXTENDING SUPPORT STRUCTURES



(57) Abstract

An exhaust treatment device, such as a catalytic converter assembly (20) for vehicles includes an inner housing (21) having an inlet and an outlet defining a longitudinal direction (63) and having a catalytic material (27, 27') therein chosen to reduce undesirable emissions from the exhaust of a combustion engine as the exhaust passes from the inlet to the outlet. The catalytic converter assembly (20) further includes an outer housing (22) enclosing the inner housing (21) but characteristically not contacting the inner housing (21), the outer housing (22) including an inlet and an outlet that align with the inlet and outlet of the inner housing (21), the inner and outer housing (21, 22) including walls (30, 31) forming a sealed cavity (26) around the inner housing (21), the cavity (26) having a vacuum drawn therein. The catalytic converter assembly (20) further includes supports (25) of various configurations and materials that extend radially between the inner and outer housings (21, 22).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
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EE	Estonia	LR	Liberia	SG	Singapore		

PCT/US 00/01499
IPEA/US 12 JAN 2001

inlet and an outlet that align with the inlet and outlet of the inner housing, the inner and outer housing including walls forming a sealed cavity around the inner housing, the cavity having a vacuum drawn therein. Supports are provided that support the inner housing in the outer housing. The supports include a radially-extending body and including a foot that slidably engages at least one of the inner and outer housing.

These and other features, advantages, and objects of the present invention will be further understood and appreciated by those skilled in the art by reference to the following specification, claims and appended drawings.

DESCRIPTION OF DRAWINGS

Fig. 1 discloses a side cross-sectional view of a catalytic converter including radially-extending spoke-like supports supporting an inner housing in a non-contacting position within an outer housing;

Fig. 2 is an end view of a modified end support including radially-extending spokes and an outer ring with a wire mesh foot;

Fig. 3 is a cross-sectional view taken along the line III-III in Fig. 2;

Fig. 3A is a cross-sectional view similar to Fig. 3, but also showing an outlet end of the modified catalytic converter of Fig. 3;

Fig. 4 is an end view of a modified end support;

Fig. 5 is a cross-sectional view taken along the line V-V in Fig. 4, including showing the inner and outer housing ends;

Figs. 6-7, Figs. 8-9, Figs. 10-11, Figs. 12-13, and Figs. 14-15 are paired figures that are similar to Figs. 4-5, respectively, with each pair of these figures showing an end view and a side view of a modified end support that includes radially-extending spoke-like legs adapted to provide secure radial support but to permit dissimilar longitudinal thermal expansion between inner and outer housings;

Figs. 16 and 17 are side cross-sectional views of additional modified catalytic converters, Fig. 17 showing more undulations in its bellows versus Fig. 16 and also having a different placement of its radiation shield;

Fig. 18 is a fragmentary enlarged cross-sectional view of the modified catalytic converter shown in Fig. 17;

Fig. 19 is an end view of another modified support;

AMENDED SHEET

Figs. 69 and 70 are cross-sectional views of the support ring in Fig. 68 taken along a plane that extends perpendicular to the longitudinal direction of the catalytic converter;

Fig. 71 is a side cross-sectional view of a modified catalytic converter having a modified spoke support system that facilitates manufacture;

Fig. 72 is an enlarged fragmentary view of a modified end construction similar to the end construction of the converter shown in Fig. 71;

Fig. 73 is an exploded view of Fig. 72; and

Fig. 74 is a schematic view of a particulate trap incorporating aspects of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The illustrated catalytic converter 20 (Fig. 1) is a vacuum-insulated converter having a core or inner housing 21 positioned within and insulated from a jacket or outer housing 22. Expansion joints 23 and 24 are provided at each end of the inner housing 21, and supports 25 and 25' are provided to support the inner housing 21 within the outer housing 22 while maintaining a vacuum-insulating cavity 26 forming a relatively constant gap around the inner housing 21. A sufficient vacuum is drawn on the cavity 26 so as to eliminate heat loss from air conduction and convection. The supports 25 and 25' within the converter design are particularly configured to accommodate longitudinal thermal expansion of the hot inner housing 21 relative to the cool outer housing 22. The internal supports 25 and 25' bridge the vacuum insulation and are sufficiently stiff to accommodate dynamic (vibration and impact) loads at temperature, yet are flexible enough to accommodate unequal thermal expansion of the inner and outer housings 21 and 22, and further are of minimal cross section size and minimal conductance to minimize heat loss.

More specifically, the inner housing 21 is preferably fabricated of metal or other material that is impermeable to gases, and is adapted to contain one or more catalyst substrates 27 and 27'. Exhaust gases from an internal combustion engine flow through the catalytic converter 20, as indicated by the arrows 28, including through the numerous small, catalyst-coated pores or channels that are formed in the catalytic substrates 27 and 27'. The inner housing 21 is enclosed within the outer housing 22, and its sidewall 30 is spaced radially inwardly from the sidewall 31 of the outer housing with the supports 25 and 25' supporting it to maintain a relatively constant gap. The

outer outlet end cone 44 to the inner outlet end cone 43 at a plurality of circumferentially spaced positions. The supports 25' include spokes 50, a hub flange 51 and a rim flange 52 that abut and are welded to the inboard and outboard inlet end cones 43 and 44. The illustrated reinforcement tube 49' and outlet tube section 46 are fixed together, and defines a space 49'' therebetween filled with getter and/or hydride material. The hydride material captures hydrogen from the insulating cavity 26 when the catalytic converter 20 is at low temperature to increase the insulation effect of the vacuum at low temperature (which helps the catalytic converter reach the operating temperature more quickly) and releases hydrogen to increase conductivity when the catalytic converter 20 is at a high temperature (to prevent over-heating). The relationship between the insulative value and the pressure of hydrogen is known in the art, such that it doesn't need to be described here for an understanding of the present invention by a person skilled in this art. The getter material removes gases from the cavity 26, and helps maintain the high vacuum in the cavity 26 for a longer service life. It is noted that many different getter/ hydride arrangements and structures are possible, as shown in provisional application serial no. 60/116,829, previously incorporated herein by reference.

End shields 56 and 57 are placed in the inlet and outlet outer tube sections 36 and 46, respectively, adjacent an outer end of the bellows 38 and 48. The end shields 56 and 57 include a plurality of holes 58 that reduce turbulence in the flow of exhaust gases through the catalytic converter 20, and also the end shields 56 and 57 slow convection heat transfer and help retain the heat within the catalytic converter 20 when the flow of exhaust stops. Further the end shields 56 and 57 may include catalytic material themselves if desired.

A phase-change material (PCM) containing housing 60 including annular end walls 62 is attached to the sidewall of the inner housing 21 in the cavity 26, and forms a sealed separate chamber around the inner housing 22. Phase change material 61 is placed in the chamber of housing 60. The phase change material 61 is formulated to change its phase and store heat during the heat-up period of the catalytic converter, and further is configured to release heat during cool-down of the catalytic converter 20. The result is that the phase change material 61 causes the inner housing 21 and catalytic materials in the substrates 27 and 27' to reach their "light-off" temperatures much more quickly. Once the catalytic materials reach the "light-off" temperature (usually about

315 – 430 degrees C), the temperature of the catalytic converter 20 raises rapidly to its operating temperature from the exothermic heat of the catalytic reactions with the exhaust gases.

The outer inlet end cone 34 forms an angle to a longitudinal direction, and the inner inlet end cone 33 forms an angle to the longitudinal direction 63, with both the outer and inner inlet end cones opening up as the exhaust gases flow into the catalytic converter 20. The spokes 40 of the illustrated supports 25 at the inlet end extend at an angle of about 45 degrees from the longitudinal direction 63 such that they interconnect the cones 33 and 34. It is noted that the spokes 50 can point inboard or outboard and be connected to other components, e.g. outer housing 22. The spokes 50 of the illustrated supports 25' at the outlet end extend at an angle of about 45 degrees from the longitudinal direction 63, such that they interconnect the cones 43 and 44. The spokes 40 and 50 of the supports 25 form spokes that are circumferentially-spaced around the bellows 38 and 48, and there are sufficient spokes 40 and 50 such that the inner housing 21 is stably supported within the outer housing 22 for non-contacting concentric support. The appearance in end view is much like a spoked wheel. The combination of the spoke-like bodies 40 with the cones 33 and 34 at the inlet end, and the spoke-like bodies 50 with the cones 43 and 44 at the outlet end, form a support structure capable of maintaining support on the inner housing 21 while still accommodating the different thermal expansion of the inner housing 21 relative to the outer housing 22 (particularly in a longitudinal direction). As illustrated, the spoke-like bodies or spokes 40 at the inlet end are longer than the spoke-like bodies 50 at the outlet end. A scope of the present invention is believed to include both configurations, and variations thereof.

When the catalytic converter 20 is in a cooled state, and the exhaust gases begin to flow (i.e. when the engine is turned on), the inner and outer housings 21 and 22 will gradually heat, with the inner housing 21 heating much sooner and faster. As it heats, the inner housing 21 will lengthen by several millimeters, such as about 4-mm, ahead of the outer housing 22. The outer housing 22 also heats, but at a slower rate and with a delayed time period and also to a lower highest temperature. This causes longitudinally-directed stress to occur on the supports 25 and 25'. The curvature of attachment hub flanges 41 and 51 to the spokes 40 and 50, respectively, and their general shape and angular attachment cause the spokes 40 and 50 to bend into a curvilinear/ concave shape, and causes them to do so simultaneously and predictably as the inner and outer housings

21 and 22 undergo different thermal expansions. The pressure of supports 25 and 25' can also cause the outlet end cones 43 and 44 to bow slightly apart from each other, depending on the strength of the supports 25 and 25'. By this predictable bending, the cavity 26 is reliably maintained around the inner housing 21 such that is does not contact the outer housing 22. The cross-sectional shape of the supports 25 and 25' is made sufficient to provide the functional strength required to hold the inner housing 21 in its isolated position within the outer housing 22, but the cross-sectional shape is minimized to reduce heat transfer along the supports 25 and 25'. The cross-sectional shape of the supports 25 and 25' vary greatly depending upon a weight of the inner housing 21 and components therein, depending upon loading (vibrational and impact) test requirements of the vehicle manufacturer, and depending upon test results and fine-tuning of the exhaust system on a given model vehicle. For example, the spokes can be made from 1.5 mm thick by 4-mm wide stainless steel material where at least three or more supports 25 (and 25') are used circumferentially around the inlet and outlets of the catalytic converter 20.

It is noted at this point, that a potentially more consistent and stable support can be achieved by the support arrangements shown in Figs. 2-73. Nonetheless, it is noted that Fig. 1 shows a good and useful structure that is believed to be satisfactory in many applications.

A plurality of modified catalytic converters are disclosed below. In order to reduce redundant discussion, each successive modification uses the same identification numbers as the earlier described embodiment, but with the addition of a letter, such as "A", "B", "AA", and etc.

CONVERTER INTERNAL SUPPORT/WIRE MESH RING END SUPPORT DESIGN

A wire mesh ring or foot 65A (Figs. 2-3A) can be used as an integral component of an end support 25A' to allow the end support 25A' to move relative to the inner or outer housings 21 and 22. The wire mesh supports one end of the converter core or roughly 50% of its weight. A highly compressed wire mesh ring acts as a high rate spring for any loads in any radial direction. However, it allows moderate axial sliding of the converter due when inner housing 21 of the converter undergoes thermal expansion. The wire mesh is built of a premium material like stainless steel or Inconel that is compatible with other mating components. For example, a high nickel stainless steel alloy such as 30% nickel can be used. This supports and positions the converter

AMENDED SHEET

core for high durability, and allows for axial and radial thermal growth. A sliding joint with an end support employing a wire mesh end, a jacket tube, a core outlet and an end support of dog bone shape spokes is set forth in Figs. 2 and 3. The illustrated wire mesh-sliding joint engages the outer housing 22 and is positioned against the jacket internal diameter. This results in about twice as much wire mesh mounting area than if it were engaged against the inner housing 21. At the jacket or outer housing 22, the operating temperatures are much lower and the wire mesh can be a lower grade stainless steel material.

More specifically, the support 25A' (Fig. 3A) includes an inner (hub) ring or hub flange 51A, and outer (rim) ring or flange 52A, and a plurality of spoke-like bodies 50A welded to the inner and outer rings 51A and 52A. The cone 43A is "bullet"-shaped to facilitate manufacture and flow distribution. The outer ring 52A forms an outwardly facing recess in which the wire mesh foot 65A is placed. The wire mesh foot 65A forms a zone of low thermal conductivity, thus resisting transfer of thermal energy from the inner housing 21A to the outer housing 22A. The wire mesh 65A slidably engages the sidewall 31A, such that the inner housing 21A is stably supported, yet allowed to grow longitudinally due to dissimilar thermal expansion. The illustrated spoke-like bodies 50A extend at an angle of about 70 degrees to the longitudinal direction 63A, and press against the wire mesh foot 65A, with the foot 65A pressing back with a spring-like force. Notably, it is contemplated that the foot 65A could also be made of other materials, such as ceramic, if desired.

The support 25B' (Figs. 4-5) includes a body 50B similar to the body 50 of support 25', but the body inner flange 51B includes an inwardly facing ring-shaped recess 66B in which a wire mesh foot 65B is positioned. The wire mesh foot 65B slidably engages the end of the inner end cone 43B. The wire mesh foot 65B must be made of a thermally resistant stainless steel since the foot 65B engages the inner housing 21B, but less of the wire mesh material is needed due to the smaller diameter of the inner housing 21B. The body 50B and the inner and outer flanges 51B and 52B are stamped as a single stamping, and are integrally formed as a single unit, without the need for secondary welding. Four bodies 50B are shown, although more or less could be designed into the support 25B'.

CONVERTER INTERNAL SUPPORT/DOG BONE SPOKED END SUPPORT DESIGNS

A scope of the present invention includes a plurality of supports 50C including "dog bone" shaped support bodies 50C (Figs. 6-7) connecting inner and outer ring flanges 51C and 52C placed at each end of the inner housing (21) and the converter core. The inner and outer flanges 51C and 52C are shaped to mateably engage the outlet (or inlet) end cones (33 and 34) of the inner and outer housings (21 and 22). The dog bone shaped support bodies 50C include enlarged inner and outer pad flanges 67C and 67C' with wide side-laterally-extending fingers shaped to facilitate joining to the inner and outer ring flanges 51C and 52C. The bodies 50C have a reduced width to minimize the cross section, which in turn minimizes the heat conductance along the cross section. This arrangement entirely supports the inner housing 21C and converter core components housed therein. It is contemplated that a quantity of dog bone shaped parts could be utilized at three to ten locations equally spaced radially around the support ring or at offset locations chosen to best resist vehicle loads. The dog bone shaped parts entirely support the converter core. A premium material like stainless steel such as Inconel would preferably be used for the dog bone shape because it has very high strength at an elevated operating temperature, and lower thermal conductivity than other nickel alloyed stainless steels. A minimum cross section would be utilized to keep heat loss to a minimum. Because the dog bone could be easily manufactured of various shapes, perhaps by stamping methods, an optimum shape can be designed, analyzed, tested and developed. A unique large shape at each end can be built that is good for welding or brazing, and that handles structural loads better than a small shape at each end. The intermediate portion of the dog bone shape can be designed so that it is larger or of better configuration only where needed to offset or handle localized high structural loads or other problems. This is to support and position converter core for high durability and minimum heat loss. It is noted that a cross section of the body 50C can be relatively flat, or the cross section can be made U-shaped or V-shaped for added stiffness.

The modified support 25D' (Figs. 8-9) has bodies 50D having a U-shaped cross section for increased stiffness. The U-shape extends from each body 50D onto the inner and outer pad flanges 67D. The enlarged pad flanges 67D and 67D' are shaped to permit a weld bead 68D to be formed along edges of the pad flanges 67D and 67D'.

The modified support 25E' (Figs. 10-11) is integrally formed from a single stamping, and has relatively flat bodies 50E that can flex in a direction parallel the longitudinal direction 63E of the catalytic converter 20. The modified support 25F' (Figs. 12-13) has bodies 50F with deeply concave cross sections that are shaped to fit into mating pockets in the inner and outer ring flanges 51F and 52F. Each of the supports 25D', 25E', and 25F' have dog bone shapes emphasizing particular functional characteristics and providing particular manufacturing and service durability characteristics.

SPOKED WHEEL CORE SUPPORT

A spoked-wheel shaped support 25G' (Figs. 14-15) includes four to eight spokes or bodies 50G that extend from its inner flange 51G to its outer flange 52G. The spokes 50G are oriented in the same radial plane as the inner and outer flanges 51G and 52G. The spokes 50G include stiffening webs 70G along their side edges, which permits a reduction in their cross-sectional thickness. The inner flange or hub 51G fits around the inlet tube section 43G at the disk or end shield 57G, and doubles as a bellows weld-reinforcing ring. The outer flange 52G engages the outer housing 22G with a leaf-spring like manner. This method of supporting the inner housing 21G and its catalytic converter core accommodates relative thermal expansion between the inner and outer housings 21G and 22G, provides excellent stability and strength for resisting dynamic loads (vibration), and resists the escape of heat stored in the inner housing 21G since the support is slightly outside the inner housing 21G. Also, the spokes 50G extend perpendicularly to the longitudinal directions 63G, such that they permit linear expansion along the longitudinal direction 63G. The inner and/or outer flanges 51G and 52G can be secured to the inner and outer housings 21G and 22G, or one of them can remain unattached and adapted to slip, to facilitate telescoping movement of the inner housing 21G relative to the support 25G'.

The catalytic converter 20H (Fig. 16) includes modified supports 25H and 25H', where each support 25H and 25H' is a single stamping having spoke-like bodies 50H, an integral inner flange 51H and an integral outer flange 52H. The inner and outer flanges 51H and 52H are each bent in the same longitudinal direction 63H, and are installed so as to face in the direction of the inner housing 21H. The outer housing 22H has bullet-nose-shaped end cones 34H and 44H, and the outer flange 52H of the supports 25H and 25H' are shaped to mateably engage the inner surface of the end cones 34H and 44H. The bullet-nose-shaped end facilitates manufacture of the outer housing 22H by allowing

the outer housing 22H to be made from a deep draw process. A radiation shield 72H is provided in the cavity 26H. The radiation shield 72H extends completely around the inner housing 21H. Specifically, the radiation shield 72H includes a center section 73H that is positioned adjacent an inner surface of the sidewall 31H of the outer housing 22H, and includes conically shaped end sections 74H that extend along the inner end cones 33H and 43H. The radiation shield 72H has ends that terminate adjacent the disks or end shields 56H and 57H. The catalytic converter 20I (Figs. 17 and 18) has a radiation shield 72I that is similar to radiation shield 72H, but radiation shield 72I has a center section 73I that is positioned adjacent the outer surface of the intermediate housing 60I and that is spaced from outer wall 31I. Also, the number of folds in the bellows 38I and 48I are increased to provide increased tolerance of longitudinal thermal expansion.

The support 25J (Figs. 19-20) of the catalytic converter 20J (Fig. 20) is a single stamping, and has four spokes or bodies 50J connecting an inner flange 51J to an outer flange 52J. The spokes 50J are relatively wide for increased stability. The bellows 38J include unique non-uniform folds, with the innermost ones 38J' of the folds characteristically not contacting the inlet tube section 36J, but permitting the inlet tube section 36J to extend inwardly within the bellows 38J a significant dimension. The support 25K (Fig. 21) is similar to support 25J, but includes a ridge or stiffening bead 75K formed longitudinally along each spoke 50K, and further includes gussets 76K formed at each end of each spoke 50K (Fig. 22). The ridge 75K can be sharply formed to for a V-shape (Fig. 23) or can be generally radiused to form a U-shape (Fig. 24). It is contemplated that the ridge 75K will be U-shaped, and the gusset 76K V-shaped. Support 25L (Fig. 25) includes spokes 50L having edge webs 77L for reinforcement (Fig. 26). Support 25M (Fig. 27) includes spokes 50M that are non-linear in a radial direction. Instead the spokes 50M have a "snake-like" curvilinear longitudinal shape, which adds to their length and accordingly reduces their conductance of heat. Support 25N (Figs. 28-31), support 25P (Figs. 32-34) and support 25Q (Figs. 35-36) disclose additional modifications that can be made to re-distribute stress and provide different beat conductance properties.

NON-SYMMETRIC CORE SUPPORTING METHOD

A catalytic converter 20EE (Fig. 66) includes a support 25EE at one end of the inner housing 21EE, with the other end being supported by the outlet tube 43EE. The outlet tube 43EE is made stiff, such that most, if not all, thermal expansion occurs at the inlet end of the inner housing 21EE. The support 25EE includes an inner flange 51EE that slidingly engages tube section 37EE of the inner inlet end cone 33EE and/or includes a flexible body 50EE that flexes as the inner housing 21EE thermally expands. A sufficient number of folds in the bellows 38EE are provided to accommodate the thermal expansion of the inner housing 21EE.

WIRE MESH RING WITH SEGMENTED CERAMIC FEET

The catalytic converter 20FF (Fig. 67) is similar to the catalytic converter 20EE in that it includes a bellows 38FF only at one end and no supports 25FF at either end. However, catalytic converter 20FF includes additional intermediate supports 85FF located at each end of the inner housing 21FF, with the supports 85FF slidingly engaging the sidewall 30 of the inner housing 21FF and the sidewall 31 of the outer housing 22FF. The intermediate supports 85FF include ceramic blocks carried by a wire mesh ring that abut the inner housing sidewall 30FF. A stop 86FF integrated in the outer housing sidewall 31FF captures the ceramic blocks on one side. An opposing stop integrated into 60FF captures the wire mesh ring on the other side. The intermediate housing 60FF is located between the stops 86FF. A radiation shield 72FF extends between the brackets or stops 86FF and along the interior surface of the outer housing 22FF. The wire mesh rings (Fig. 68) interrupt the radiation shield 72FF.

A support 85GG (Figs. 69-70) includes a wire mesh ring 87GG with segmented ceramic feet 88GG (four to eight) provided on the inside diameter of the support 85GG. The feet 88GG are attached to the ring 87GG by crimping the wire mesh over recesses in the ceramic feet 88GG. Support rings 87GG are located inboard of the ends of the inner housing (21), at the outer ends of the sidewalls (30). This catalytic converter core support method accommodates relative thermal expansion between the core and jacket, reacts dynamic loads (hot vibration), and resists the escape of heat stored in the core.

MODIFIED CATALYTIC CONVERTER STRUCTURE

A modified catalytic converter 20HH (Fig. 71) includes a support 25HH at its inlet end having an inner ring flange or hub 51HH, an outer ring flange or rim 52HH, and spokes 50HH connecting the hub 51HH to the rim 52HH. The outer ring flange

converter 20HH (including the bellows 38HH and 48HH). It is noted that the end sections 96HH and 97HH overlap onto longitudinal edges of the center section 95HH to provide maximum radiation-resisting values, yet to allow the spokes 50HH at each end to extend between the inner and outer housings 21HH and 22HH. The inlet end section of the catalytic converter 20HH is similar to the outlet end section, and its description need not be repeated in order for a person of ordinary skill to understand the present construction, or for such a person to understand the inventive aspects thereof.

The catalytic converter 20II (Figs. 72 and 73) includes an outlet end section similar to that of catalytic converter 20HH, but the catalytic converter 20II includes a vacuum maintenance device 32II that includes getter material for maintaining a high vacuum in the cavity 26II. Alternatively, or at the same time, the vacuum maintenance device 32II may include hydride material for passively increasing the amount of hydrogen gas within the cavity 26II when the inner housing 21II heats up. By increasing hydrogen gas at high temperature, the insulative value of the vacuum cavity 26II is reduced, thus helping throw off heat and helping to prevent overheating of the catalytic converter 20II. By reducing hydrogen gas at low temperature, the insulative value of the vacuum cavity 26II is increased, thus assisting in faster heat up of the catalyst in the catalytic converter 20II during initial engine starts. Notably, the device 32II is positioned relatively close to the inlet or outlet tube 92II such that it quickly receives heat from hot gases passing through the catalytic converter 20II. These hot gases are indicative of the temperature of the catalyst material in the catalytic converter 20II. As a result, the device 32II is able to quickly respond to actual temperature conditions of the catalytic converter material, which can be important to good operation.

In order to quickly and economically achieve a high vacuum in the cavity 26II, it is necessary to bake the catalytic converter 20II at high temperature so that gases and volatile agents are driven off. However, hydride materials, which release hydrogen at high temperatures, are undesirably activated to release their hydrogen at the same high temperatures necessary for a good bake-out. Further, after the bake-out, the cavity 26II must be sealed to maintain the vacuum. A problem occurs in that it is difficult to bake-out a cavity 26II and then seal the cavity 26II to maintain the high vacuum, without also prematurely activating the getter or hydride materials. The end construction shown in Fig. 72 solves this problem.

cavity 26II is sealed. Thus, when the getter material cools and become active, it merely begins doing its intended job, which is to absorb gas to maintain the high vacuum. It is noted that this additional heat may also activate the hydride material, but this is not a problem since, as noted above, the bake-out has already occurred and the cavity 26II is sealed. Thus the hydride material merely begins doing its intended job, which is to release hydrogen into the cavity 26II when the hydride is at an elevated temperature.

PARTICULATE TRAP FOR DIESEL EMISSIONS

A particulate trap 160JJ(Fig. 74) is often used to trap soot and carbon particulates in the exhaust from diesel engines, and to burn off these particles in a safe and non-polluting manner. The present technology can also be used in particulate traps, as described below. The detail of particulate traps and their operation is not needed for an understanding of the present invention. It is sufficient to know that particulate traps require considerable heat and have a relatively high operating temperature for optimal operation. During cold starts, when the particulate trap is cold, it is inefficient and does not operate effectively. Accordingly, all of the discussion above in regard to providing thermal control and management of the vacuum cavity applies, including the discussion relative to PCM materials, vacuum atmospheric/hydrogen control and insulative control, and reflective shields.

Particulate trap 160JJ is similar to the converter structure 20 in that the particulate trap 160JJ includes inner and outer housings 21JJ and 22JJ spaced apart to define a vacuum cavity 26JJ. The inner and outer housings 21JJ and 22JJ include inlet and outlet ends where exhaust is received and emitted, respectively. An intermediate housing 60JJ holds PCM material adjacent the inner housing 21JJ. Getter material is provided to maintain the vacuum in the cavity 26JJ for a long service life. Hydride materials are provided to emit hydrogen once an operating temperature is achieved, so that the particulate trap does not overheat. Radiation shields 72JJ are wrapped loosely around the intermediate housing 60JJ for reflecting heat energy to prevent undesired heat loss. It is to be understood that the cavity 26JJ can be actively or passively thermally managed. The thermally-activated particulate trap device 161JJ is located inside inner housing 21JJ, and potentially includes a regeneration method of fuel- fired thermal assist or fuel additive chemical assist to promote complete burning of the carbon particles and soot found in diesel exhaust.

AMENDED SHEET

The claimed invention is:

1. An exhaust treatment device for a vehicle, comprising:

an inner housing having an inlet and an outlet defining a longitudinal direction and having a thermally-activated exhaust treatment device therein chosen to reduce emissions from the exhaust of a combustion engine as the exhaust passes from the inlet to the outlet;

an outer housing enclosing the inner housing but characteristically not contacting the inner housing, the outer housing including an inlet and an outlet that align with the inlet and outlet of the inner housing, the inner and outer housing including walls forming a sealed cavity around the inner housing, the cavity having a vacuum drawn therein; and

a support including a plurality of spokes that extend radially between the inner and outer housings.

2. The device defined in claim 1, wherein the spokes having a cross section chosen to provide strength to hold the inner housing in the outer housing without permitting contact between the inner and outer housing, but further being sized to minimize conductive heat loss through the spokes from the inner housing to the outer housing.

3. The device defined in claim 2, wherein the spokes being made from a high nickel stainless steel sheet that is greater than 30% nickel.

4. The device defined in claim 3, wherein the spokes are made from sheet material.

5. The device defined in claim 3, wherein the spokes include inner and outer ends, one of the inner and outer ends including wire mesh supporting the one end on the associated one of the inner and outer housing.

6. An exhaust treatment device for a vehicle, comprising:

an inner housing having an inlet and an outlet defining a longitudinal direction and having a thermally-activated exhaust treatment device therein chosen to reduce emissions from the exhaust of a combustion engine as the exhaust passes from the inlet to the outlet;

an outer housing enclosing the inner housing but characteristically not contacting the inner housing, the outer housing including an inlet and an outlet that align with the inlet and

outlet of the inner housing, the inner and outer housing including walls forming a sealed cavity around the inner housing, the cavity having a vacuum drawn therein; and

a support including a plurality of spokes that extend radially between the inner and outer housings, the spokes having a cross section chosen to provide strength to hold the inner housing in the outer housing without permitting contact between the inner and outer housing, but further being sized to minimize conductive heat loss through the spokes from the inner housing to the outer housing, the spokes being made from a high nickel stainless steel that is greater than 30% nickel and including inner and outer ends, one of the inner and outer ends including ceramic pads supporting the one end on the associated one of the inner and outer housing.

7. The device defined in claim 1, wherein the spokes are made from an alloy steel material including nickel.

8. The device defined in claim 1, wherein the spokes have a cross section that is less than about 1.5 mm in its narrowest dimension.

9. The device defined in claim 1, wherein the spokes include inner and outer ends, one of the inner and outer ends including wire mesh supporting the one end on the associated one of the inner and outer housing.

10. An exhaust treatment device for a vehicle, comprising:

an inner housing having an inlet and an outlet defining a longitudinal direction and having a thermally-activated exhaust treatment device therein chosen to reduce emissions from the exhaust of a combustion engine as the exhaust passes from the inlet to the outlet;

an outer housing enclosing the inner housing but characteristically not contacting the inner housing, the outer housing including an inlet and an outlet that align with the inlet and outlet of the inner housing, the inner and outer housing including walls forming a sealed cavity around the inner housing, the cavity having a vacuum drawn therein; and

a support including a plurality of spokes that extend radially between the inner and outer housings, the spokes including inner and outer ends, one of the inner and outer ends including ceramic pads supporting the one end on the associated one of the inner and outer housing.

11. The device defined in claim 1, wherein the support slidably engages one of the inner and outer housings.

12. The device defined in claim 1, wherein the spokes are flexible in a direction perpendicular to their length, such that the spokes flex to accommodate a relative increase in a length of the inner housing over the outer housing when the inner housing thermally expands significantly more than the outer housing.

13. The device defined in claim 1, wherein the spokes are elongated and have a length to width ratio of at least about 3 to 1.

14. The device defined in claim 1, wherein the spokes have a tubular cross section.

15. An exhaust treatment device for a vehicle, comprising:

an inner housing having an inlet and an outlet defining a longitudinal direction and having a thermally-activated exhaust treatment device therein chosen to reduce emissions from the exhaust of a combustion engine as the exhaust passes from the inlet to the outlet;

an outer housing enclosing the inner housing but characteristically not contacting the inner housing, the outer housing including an inlet and an outlet that align with the inlet and outlet of the inner housing, the inner and outer housing including walls forming a sealed cavity around the inner housing, the cavity having a vacuum drawn therein; and

a support including a plurality of spokes that extend radially between the inner and outer housings, wherein the support comprising a one-piece component having an inner ring flange and an outer ring flange with the plurality of spokes extending therebetween.

16. The device defined in claim 1, wherein the exhaust treatment device includes a catalytic material.

17. An exhaust treatment device for vehicles comprising:

an inner housing having an inlet and an outlet defining a longitudinal direction and having a thermally-activated exhaust treatment device therein chosen to reduce emissions from the exhaust of a combustion engine as the exhaust passes from the inlet to the outlet;

an outer housing enclosing the inner housing but characteristically not contacting the inner housing, the outer housing including an inlet and an outlet that align with the inlet and outlet of the inner housing, the inner and outer housing including walls forming a sealed cavity around the inner housing, the cavity having a vacuum drawn therein; and

a support that support the inner housing in the outer housing, the support including a radially-extending body and including a foot that engages at least one of the inner and outer housing, the foot including an insulative material different from the body, the insulative material being chosen to minimize conductance of heat.

18. The device defined in claim 17, wherein the feet include insulative material selected from one of wire mesh and ceramic.

19. The device defined in claim 18, wherein the feet include wire mesh.

20. The device defined in claim 18, wherein the feet include ceramic pads.

21. The device defined in claim 17, wherein the feet comprise a composite.

22. The device defined in claim 17, wherein the feet slidably engage the one housing.

23. The device defined in claim 17, wherein the exhaust treatment device includes a catalytic material.

24. Canceled.

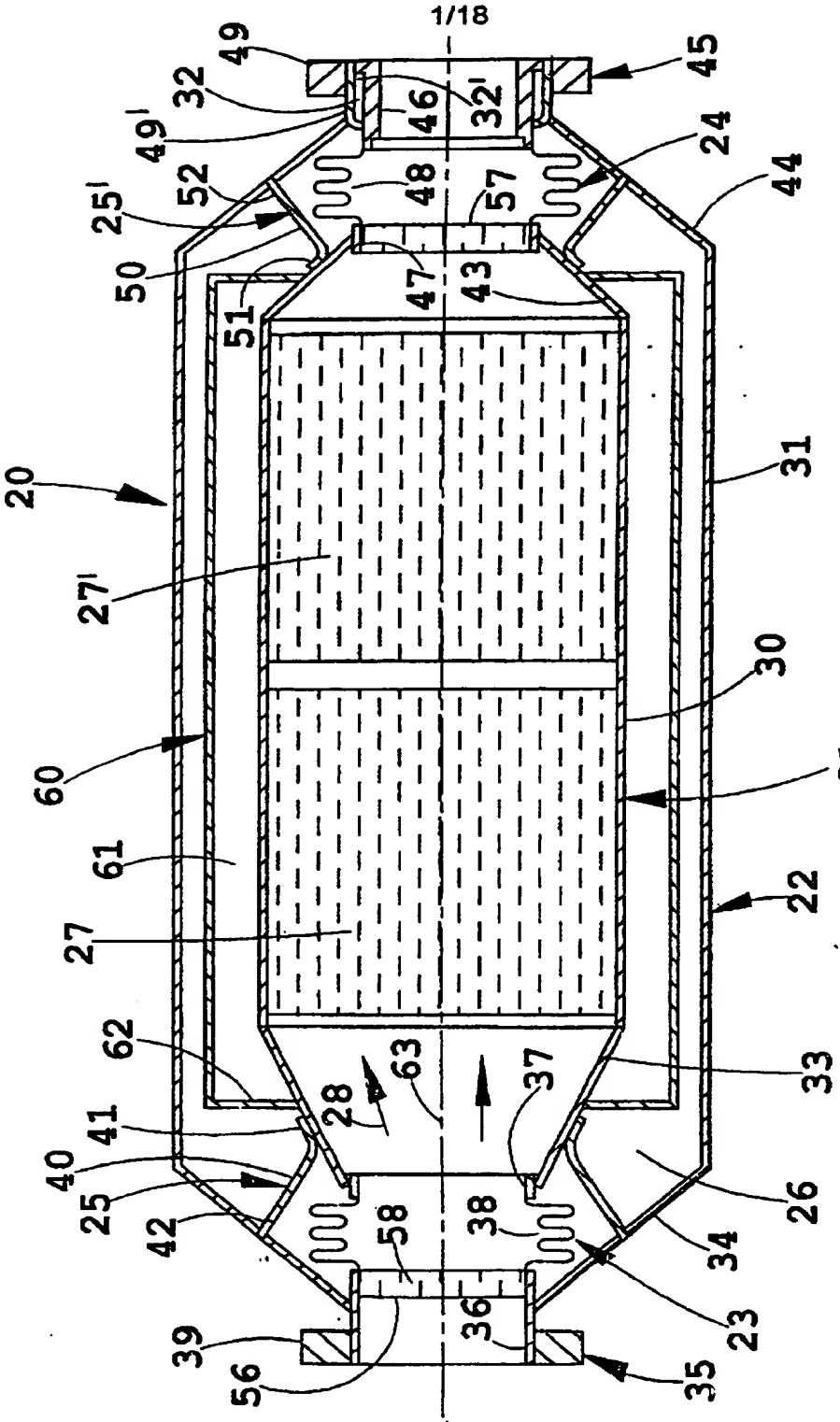


FIG.1

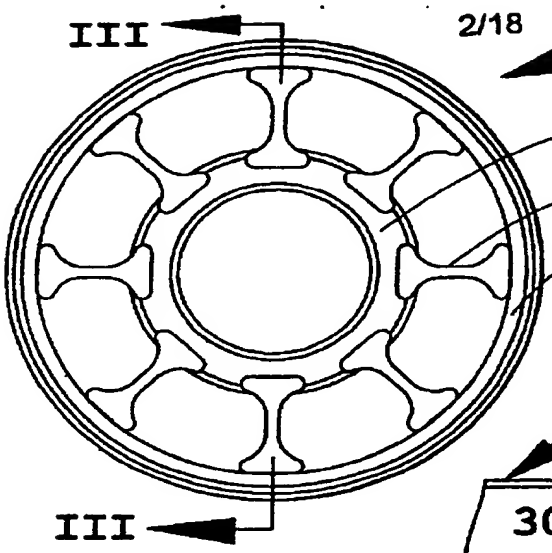


FIG. 2

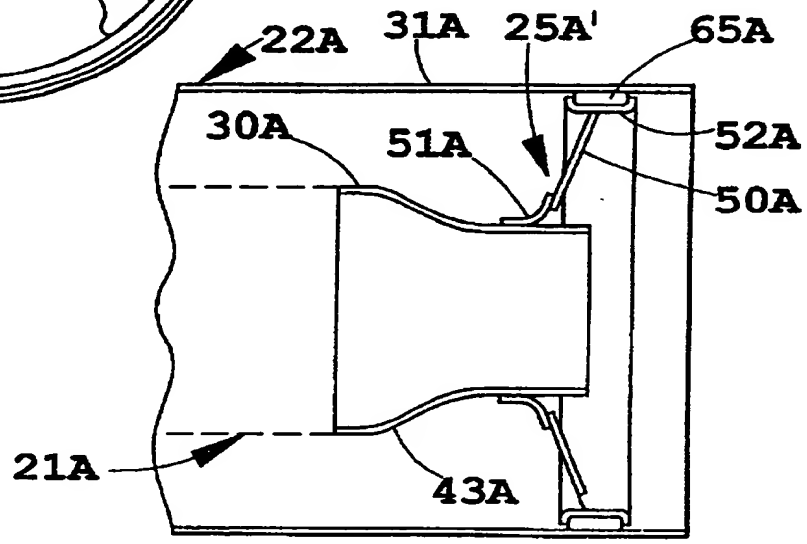


FIG. 3

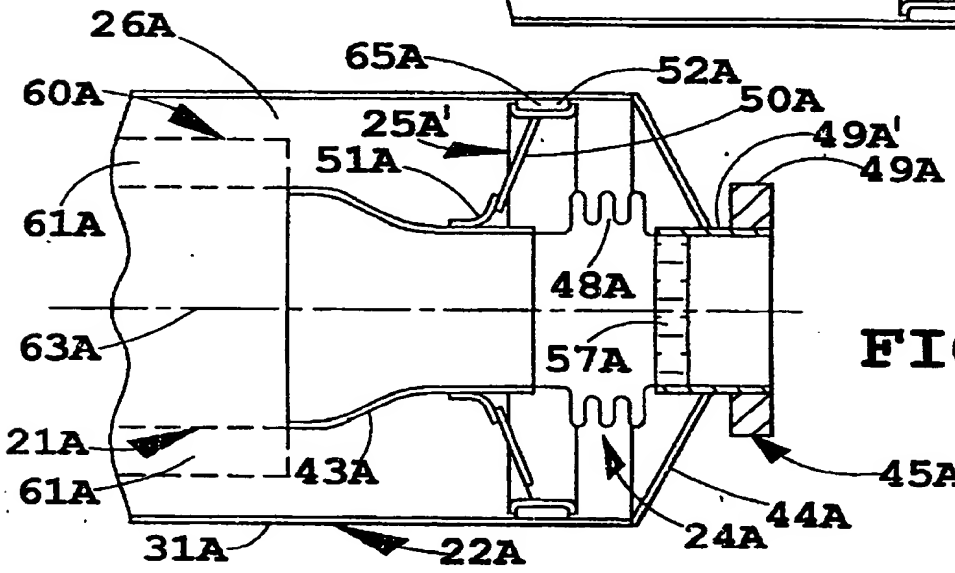


FIG. 3A

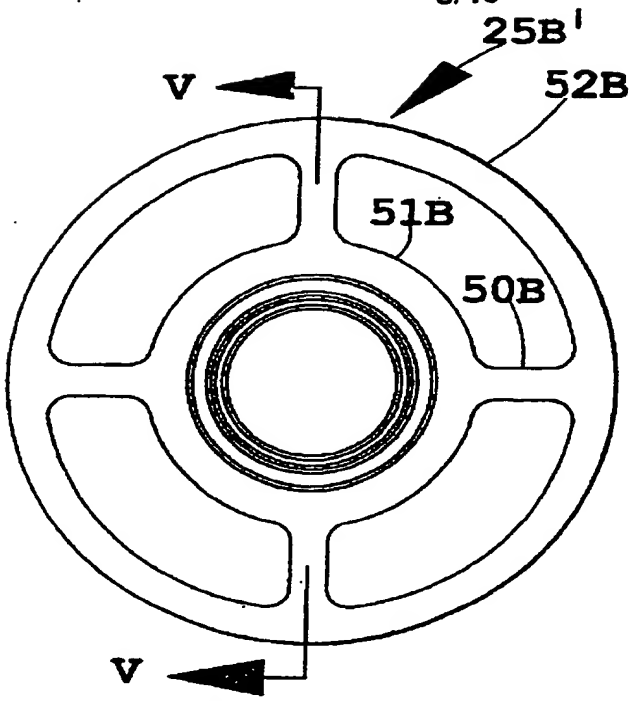


FIG. 4

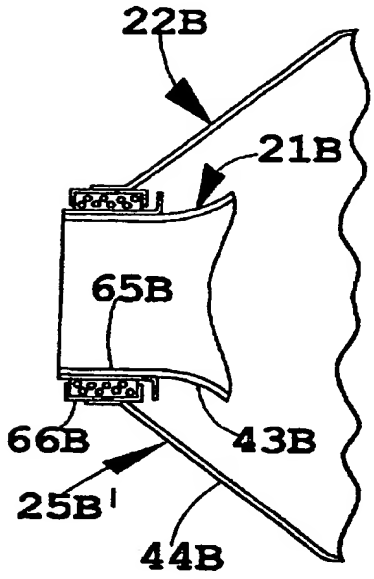


FIG. 5

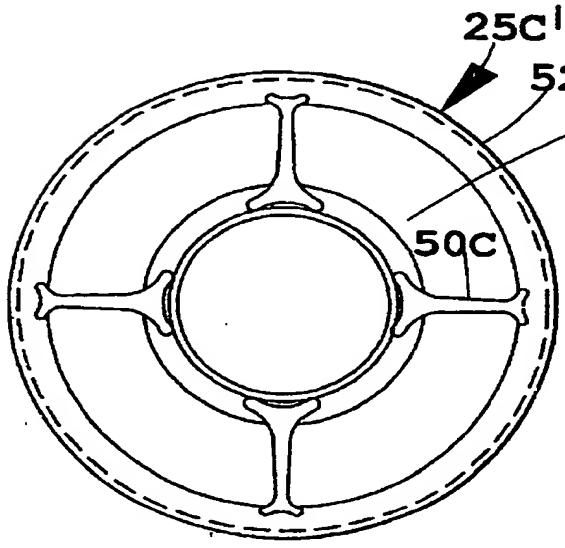


FIG. 7

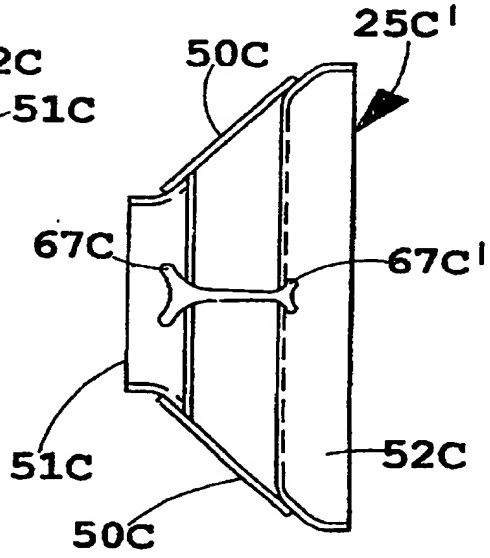


FIG. 6

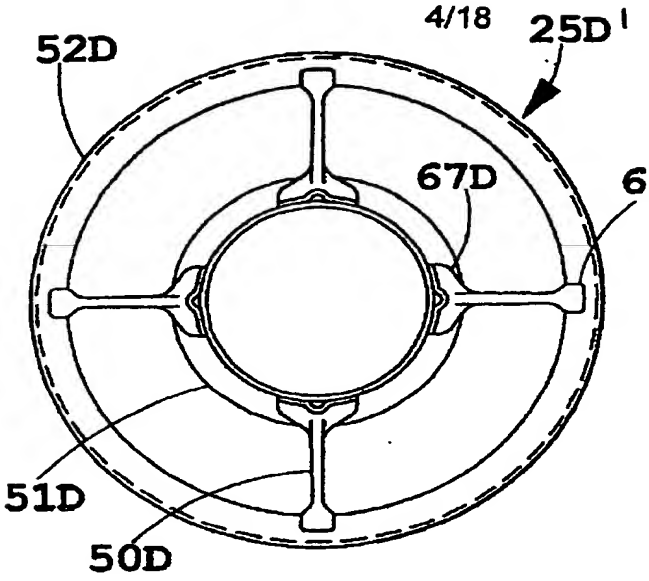


FIG. 9

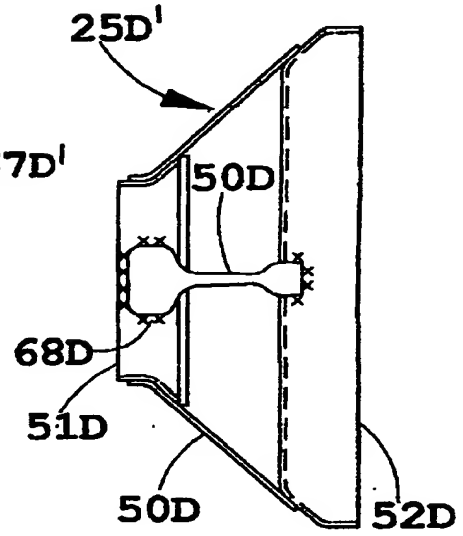


FIG. 8

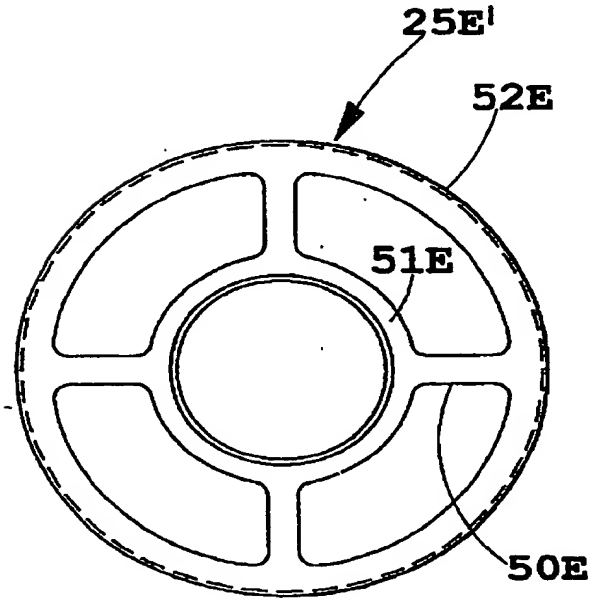


FIG. 11

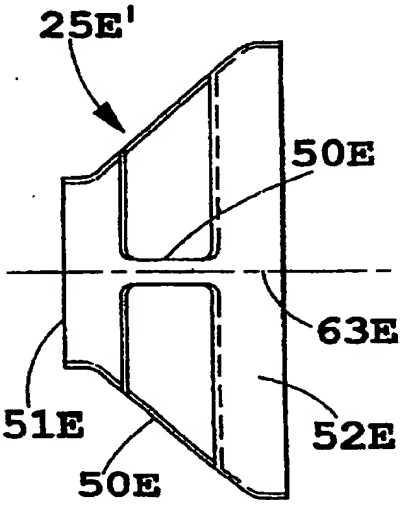


FIG. 10

PCT/US 00/01499
IPEA/US 12 JAN 2001

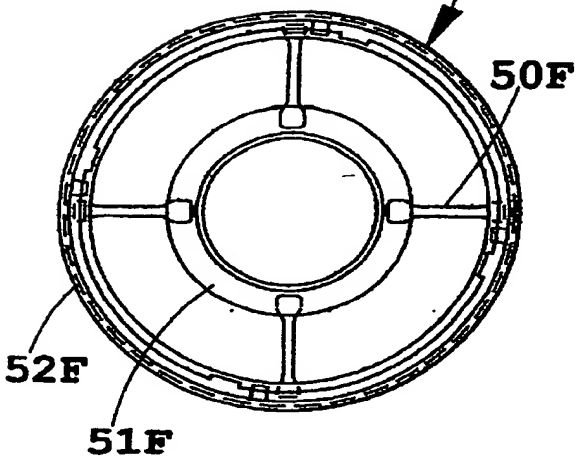


FIG.13

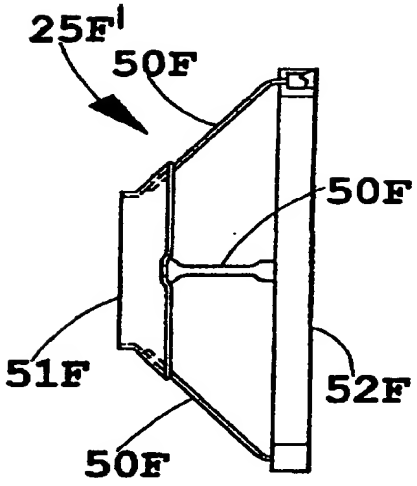


FIG.12

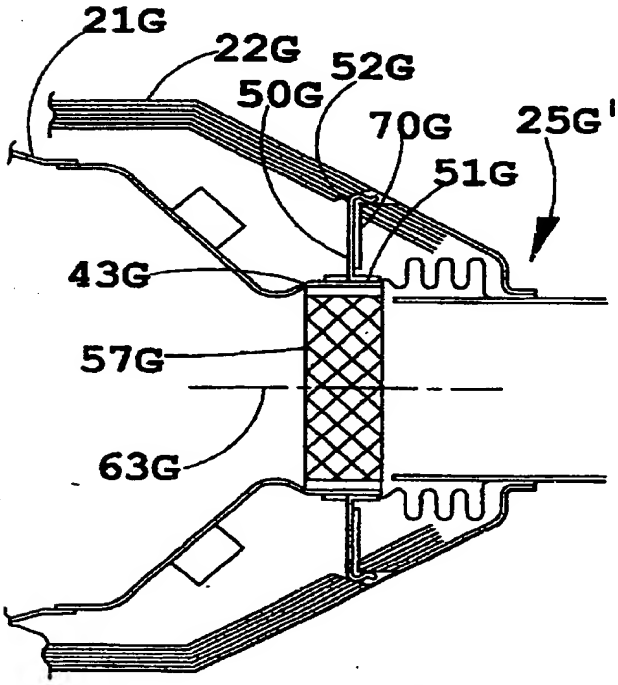


FIG.15

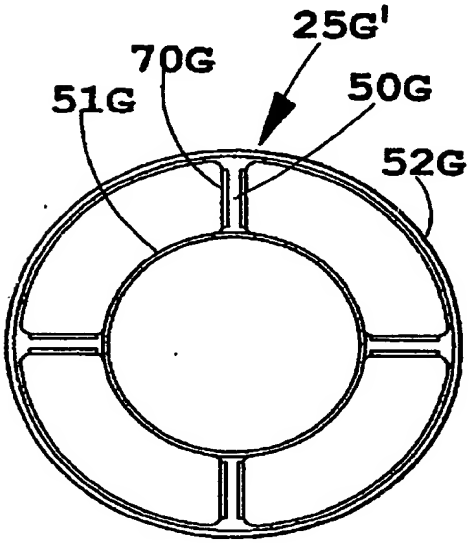


FIG.14

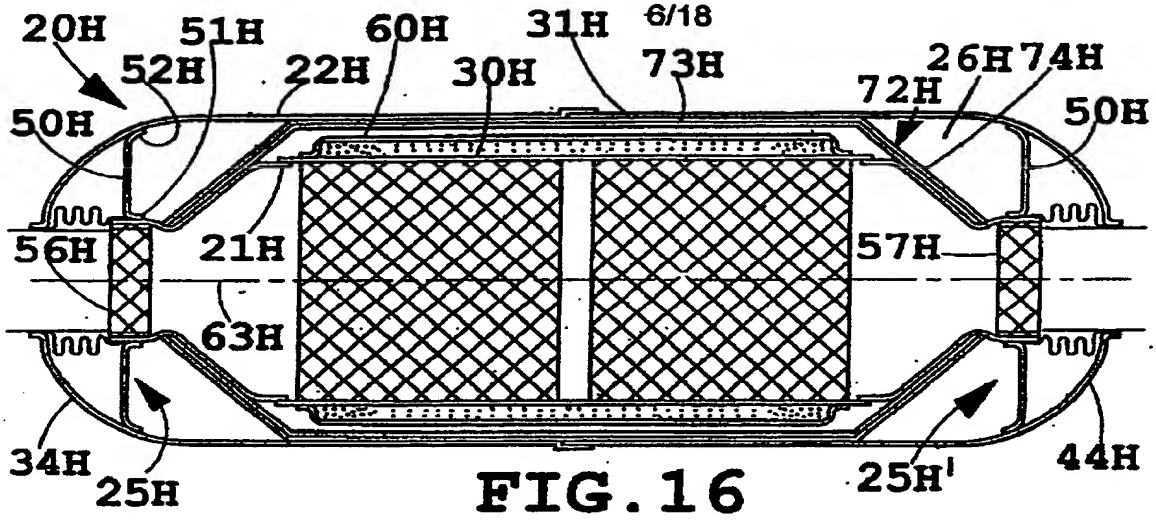


FIG. 16

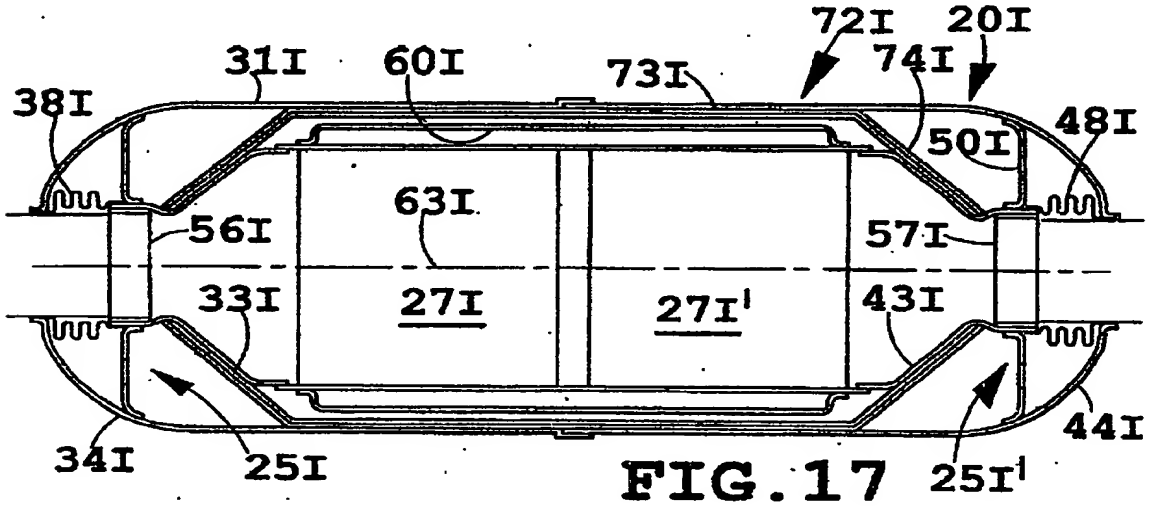


FIG. 17

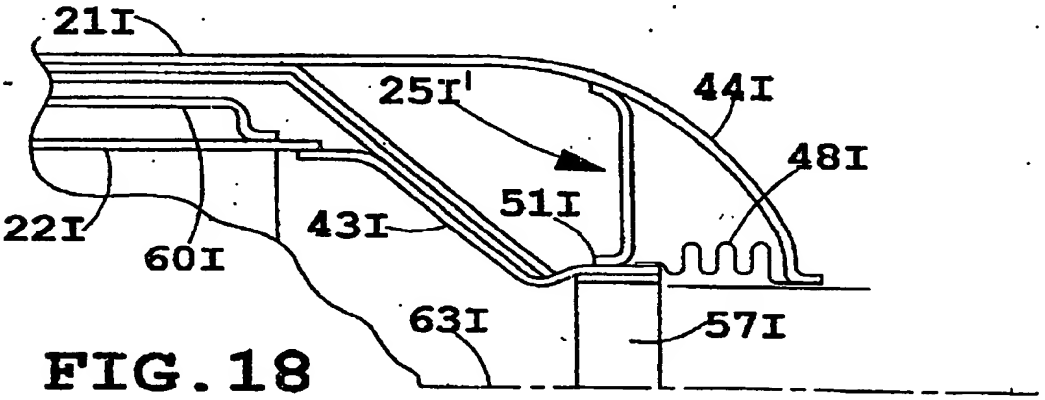
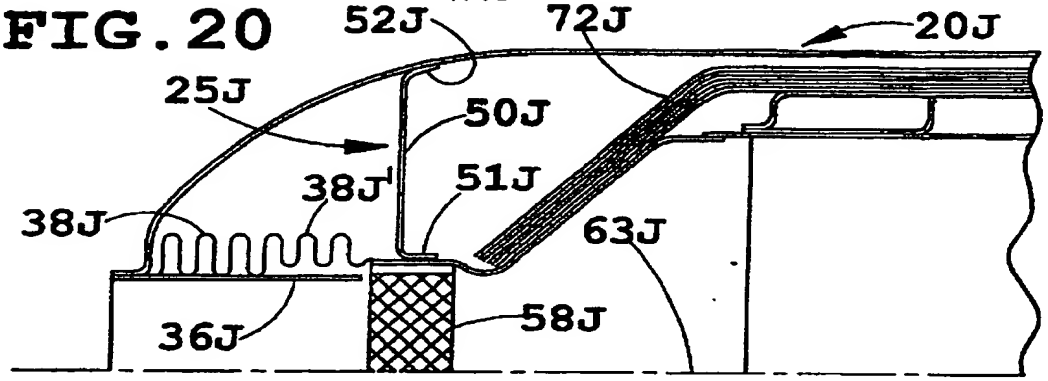


FIG. 18

AMENDED SHEET

PCT/US 00/01499
IPEA/US 12 JAN 2001

FIG.20



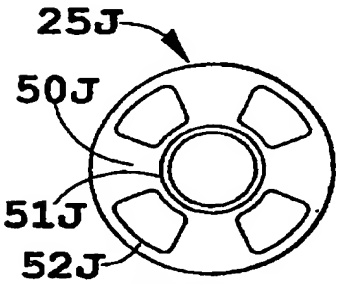


FIG.19

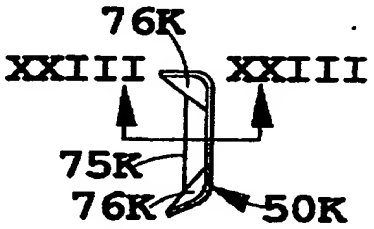


FIG.22

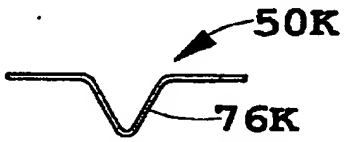


FIG.23

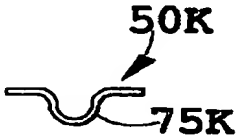


FIG.24

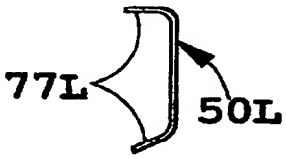


FIG.26

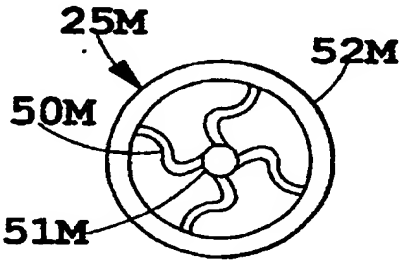


FIG.27

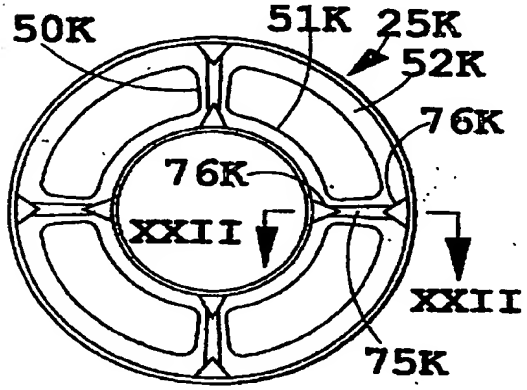


FIG.21

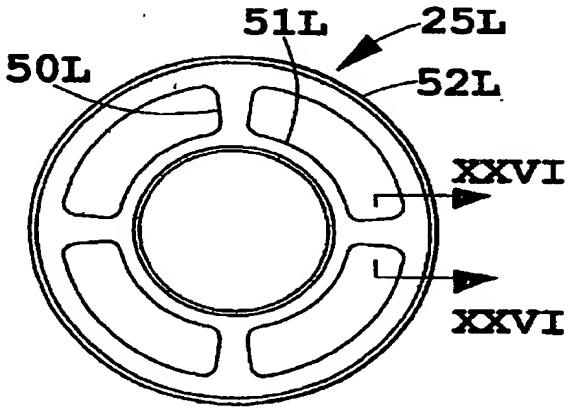


FIG.25

PCT/US 00/01499
IPEA/US 12 JAN 2001

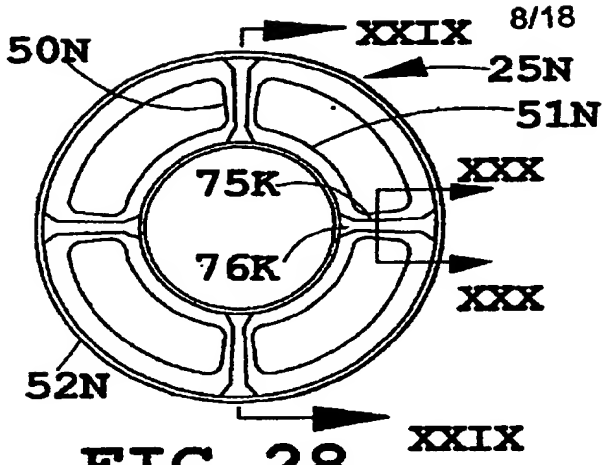


FIG.28

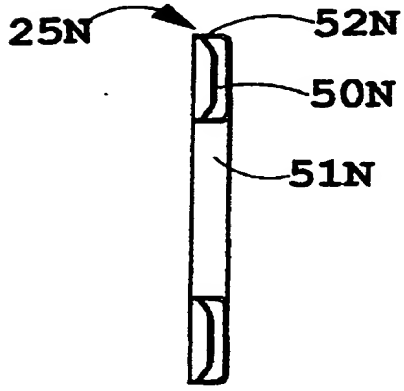
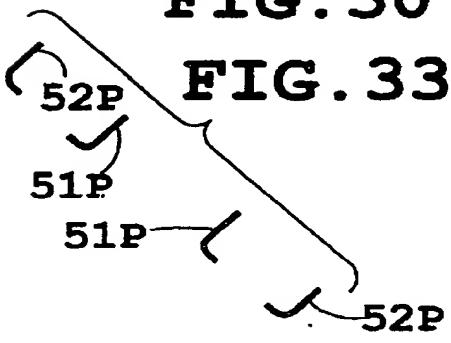


FIG.29

FIG.30

FIG.31

FIG.33



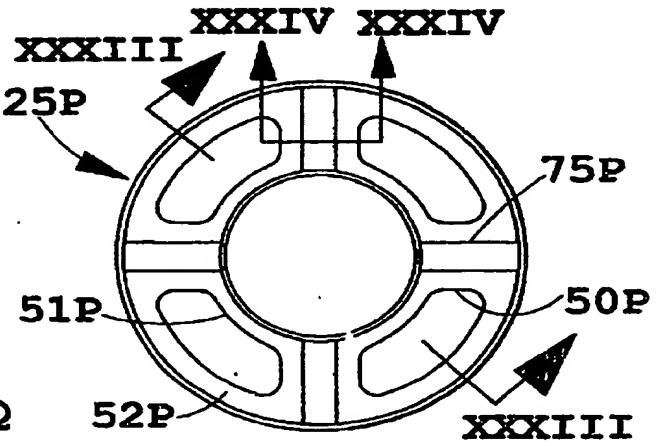


FIG.32

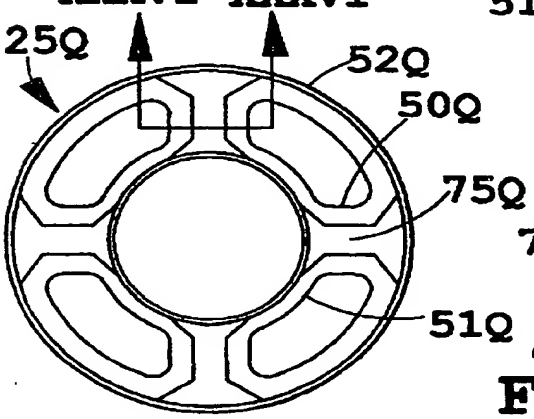


FIG.35

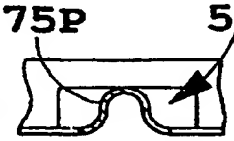


FIG.34

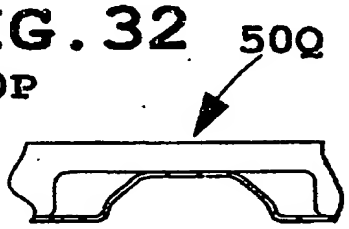


FIG.36

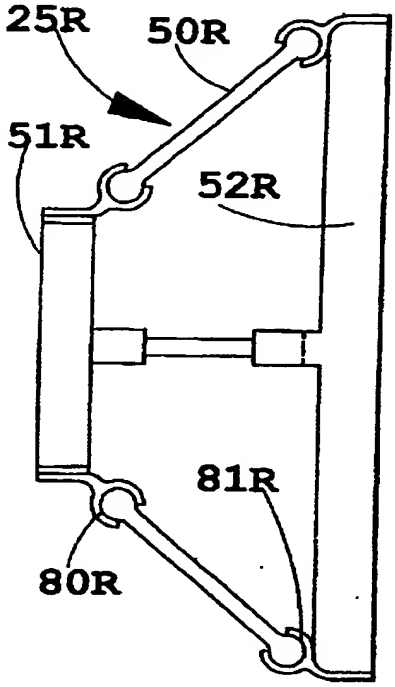


FIG. 37

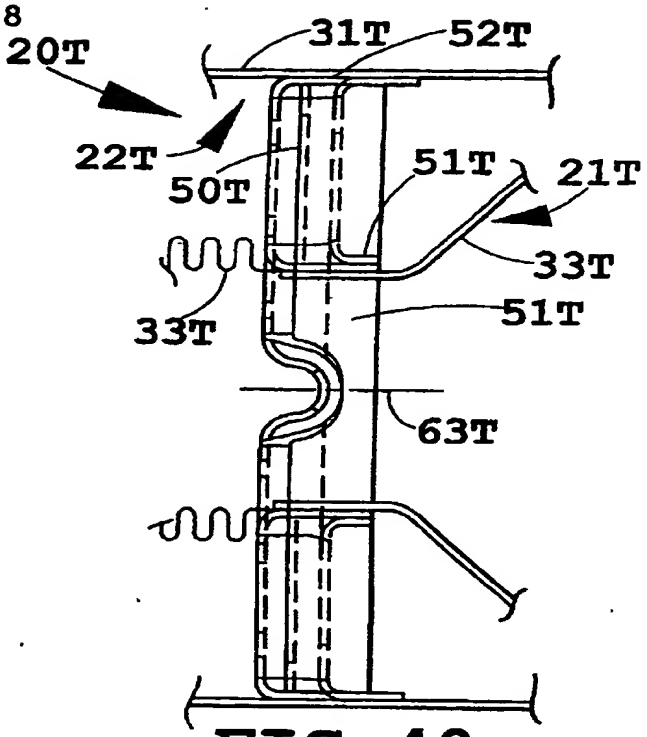


FIG. 40

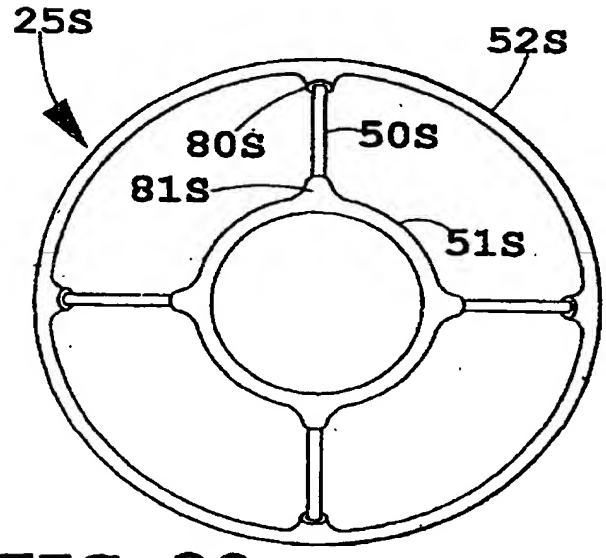


FIG. 39

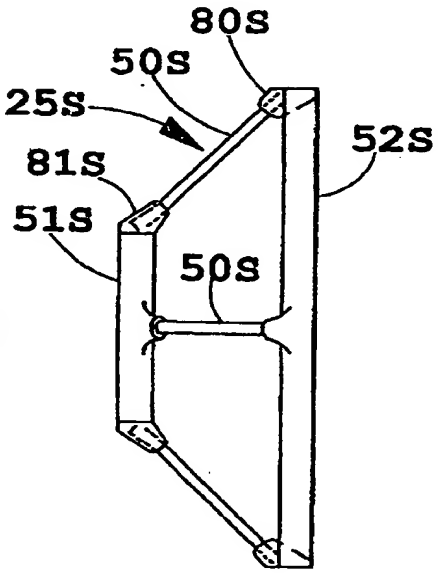


FIG. 38

PCT/US 00/01499
IPEA/US 12 JAN 2001

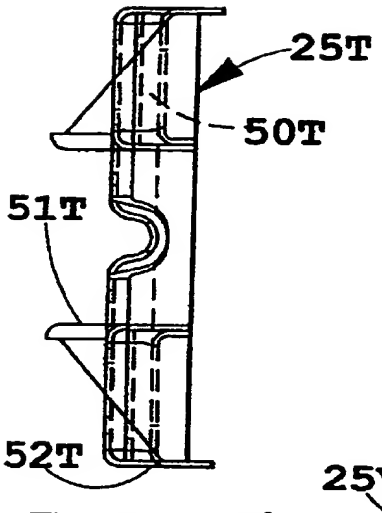


FIG. 42

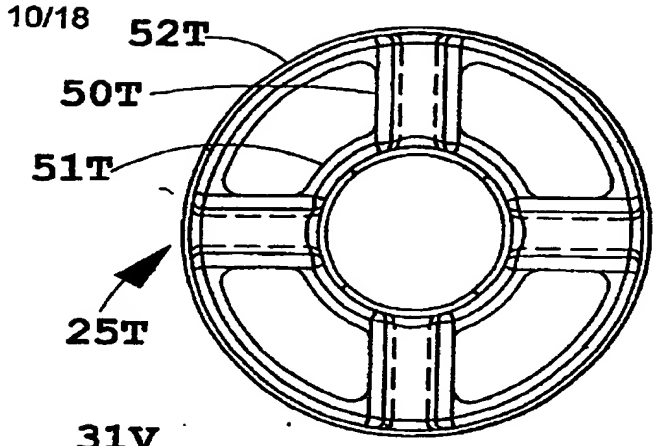


FIG. 41

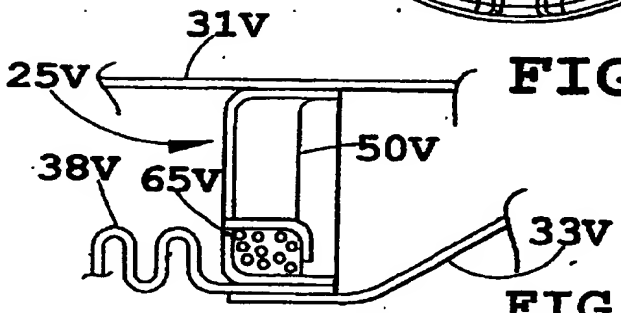


FIG. 45

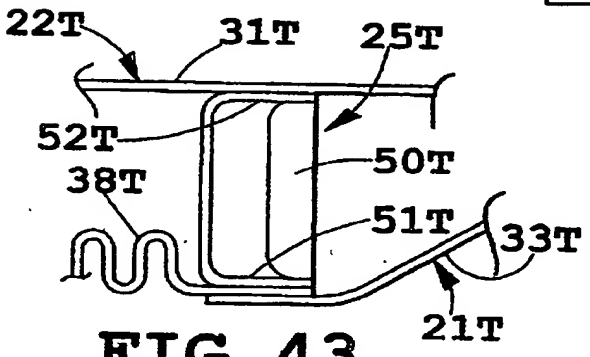


FIG. 43

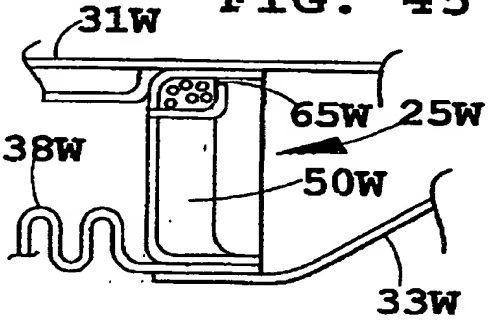


FIG. 46

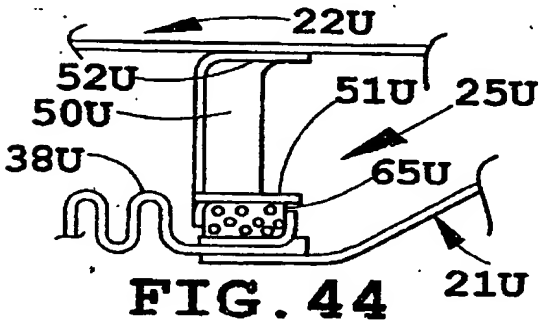


FIG. 44

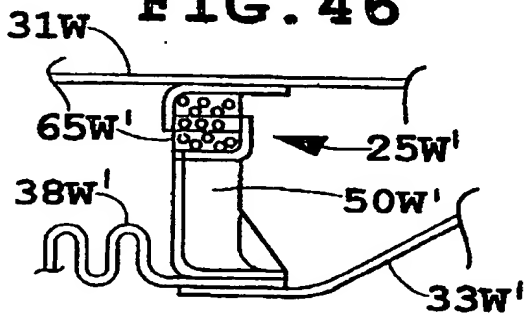


FIG. 47

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PCT/US 00/01499
IPEA/US 12 JAN 2001

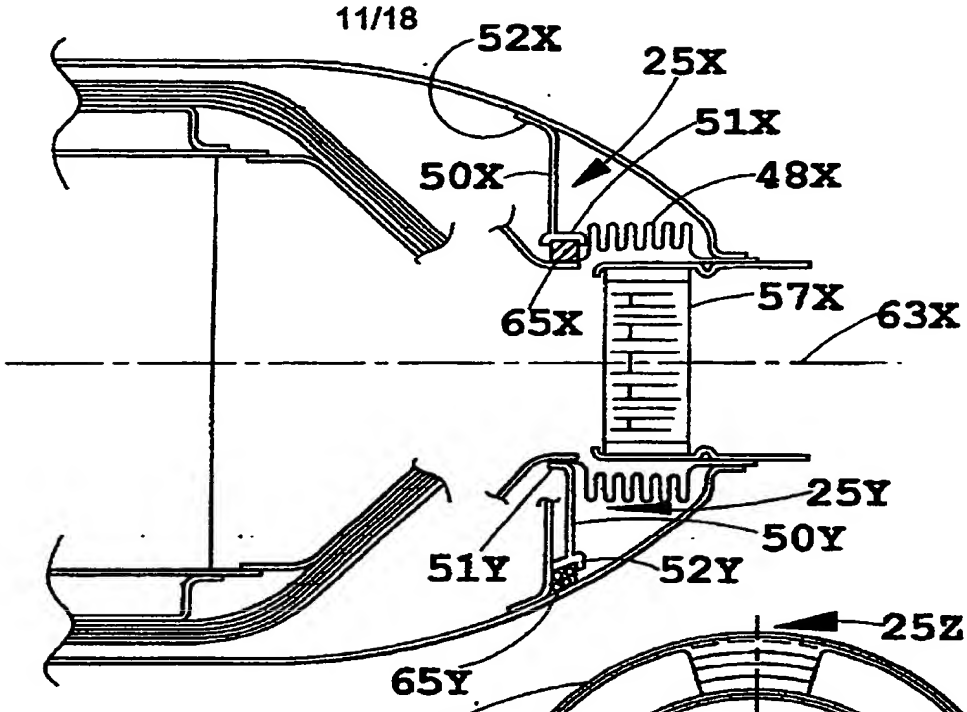

FIG. 48

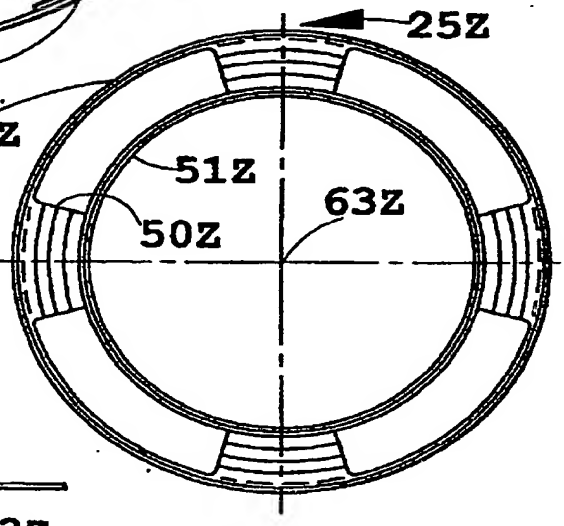

FIG. 50

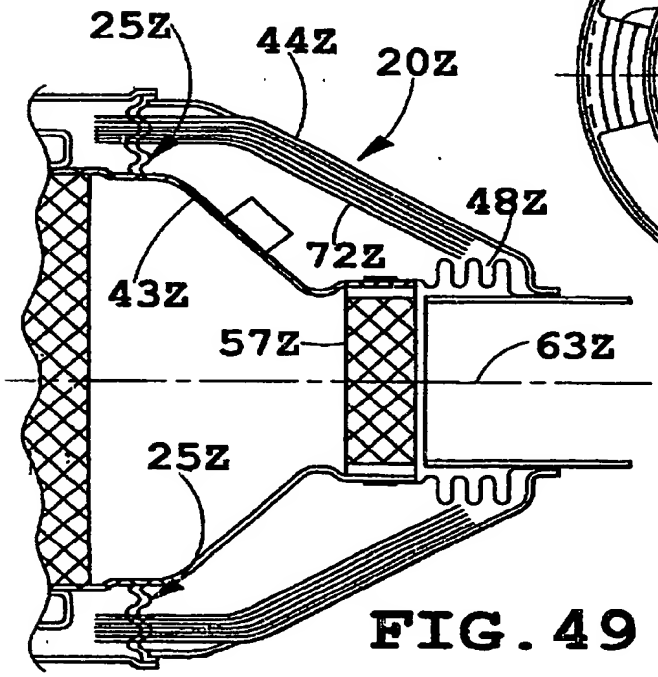

FIG. 49

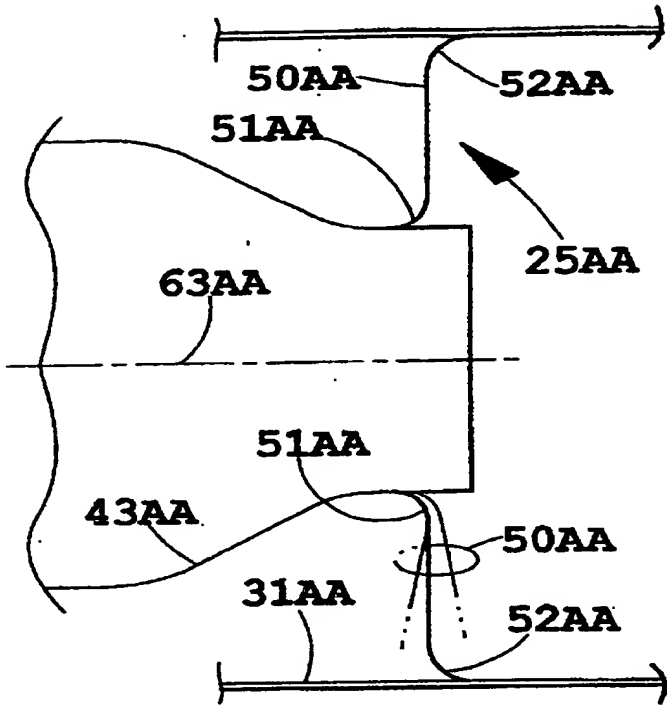

FIG.51

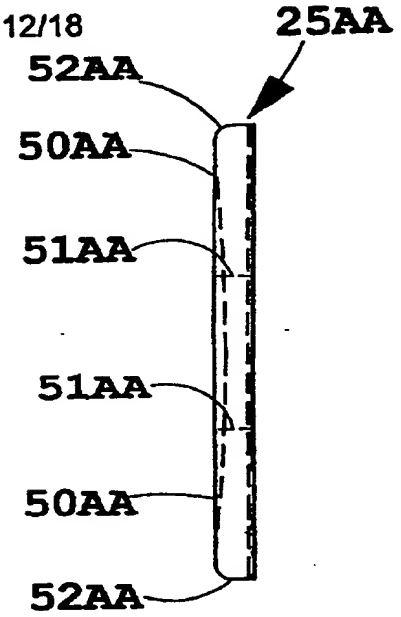

FIG.53

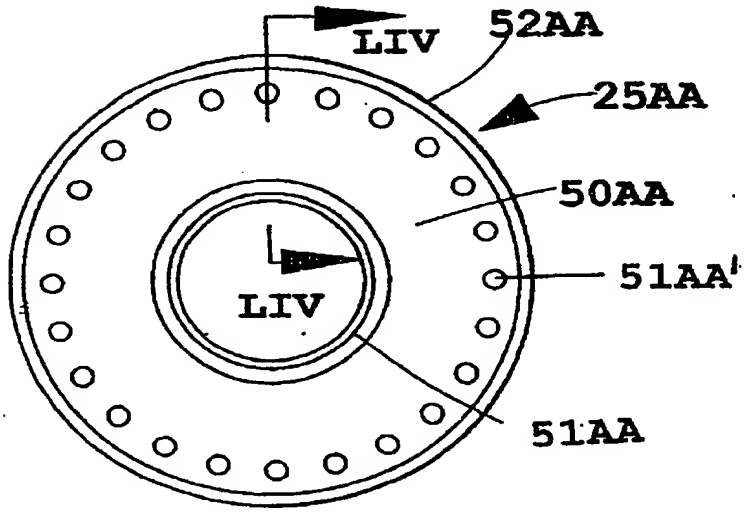

FIG.52

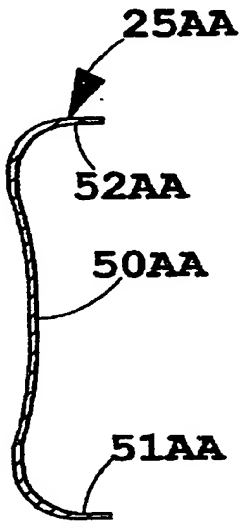

FIG.54

PCT/US 00/01499
IPEA/US 12 JAN 2001

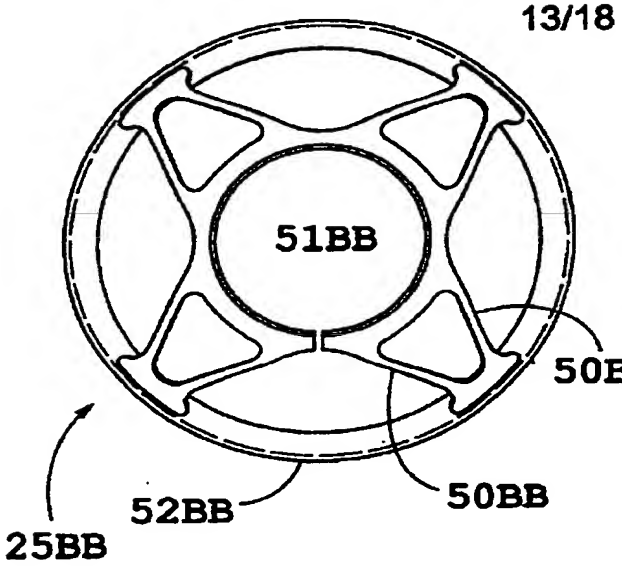

FIG. 55

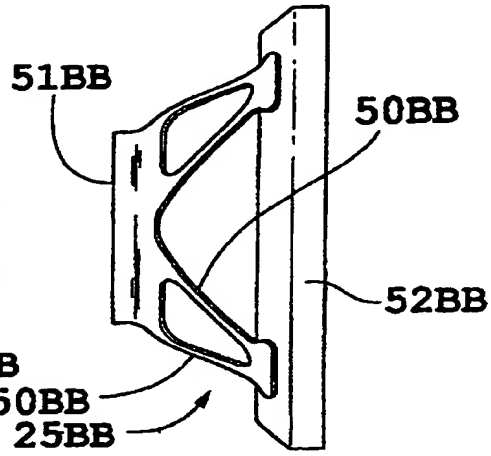

FIG. 56

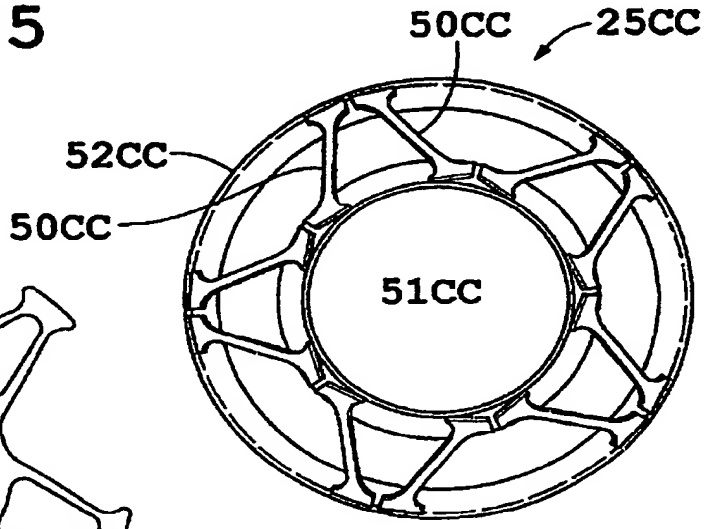

FIG. 58

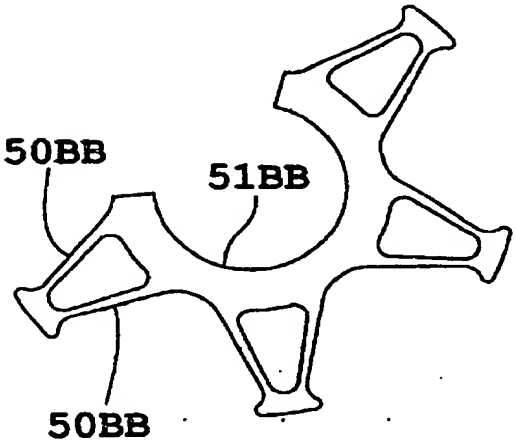

FIG. 57

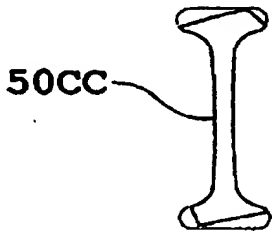

FIG. 59

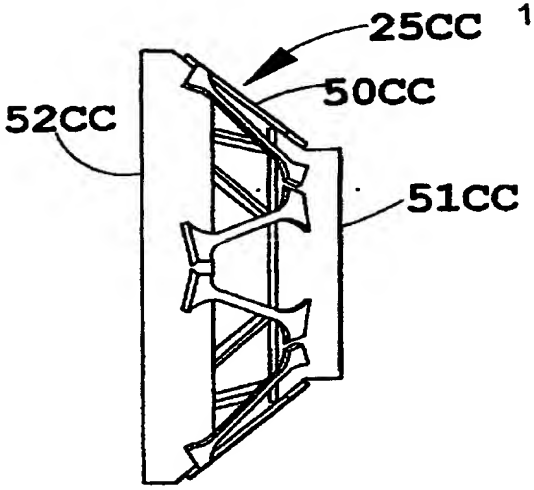

FIG. 60

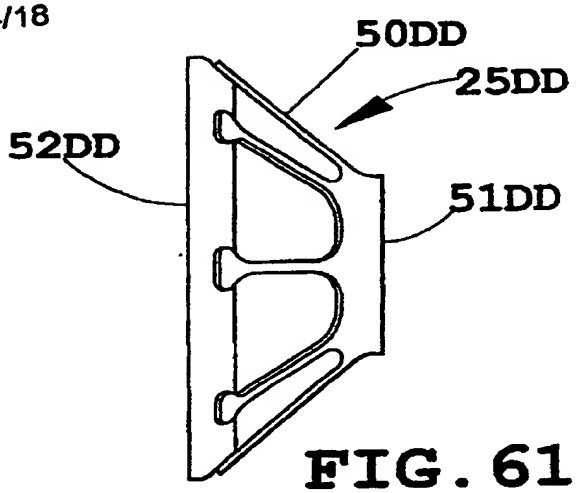

FIG. 61

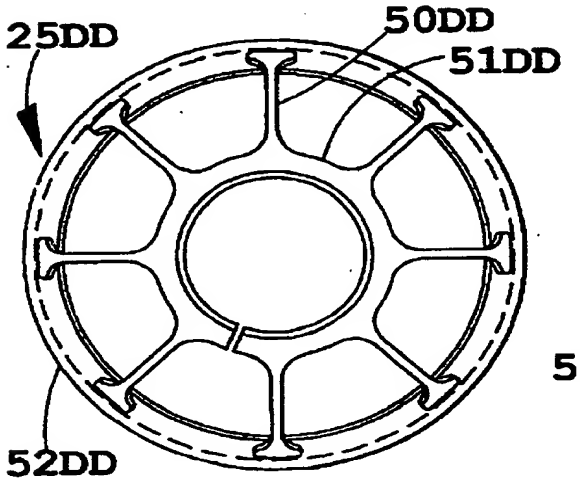

FIG. 63

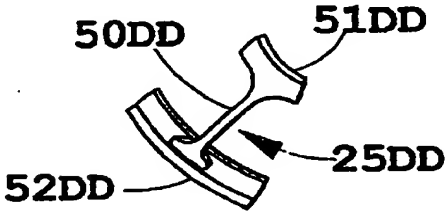

FIG. 62

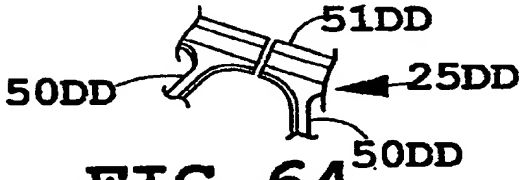

FIG. 64

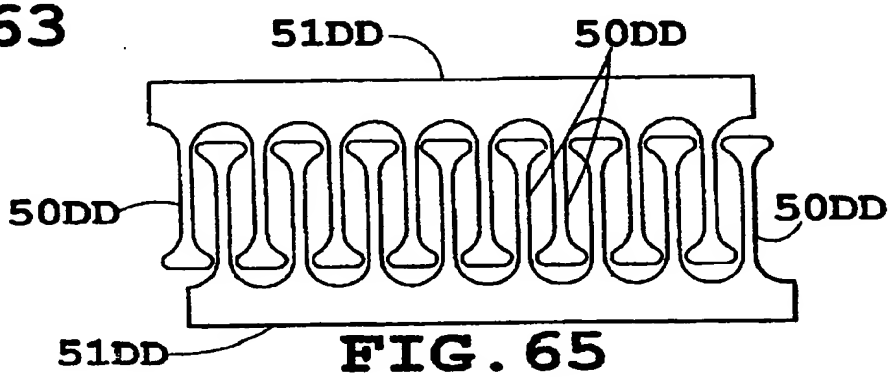

FIG. 65

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PCT/US 00/0149

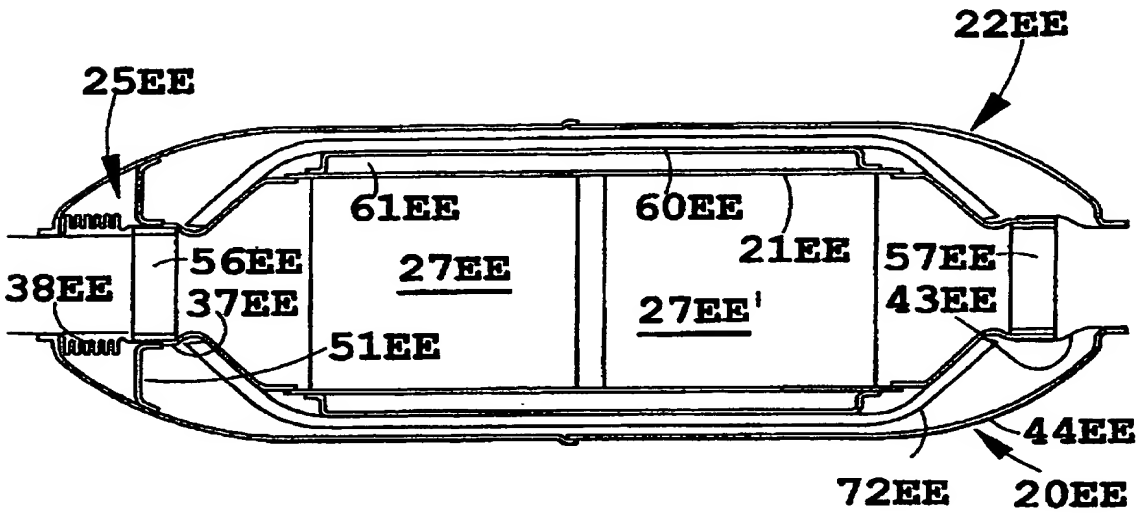

FIG. 66

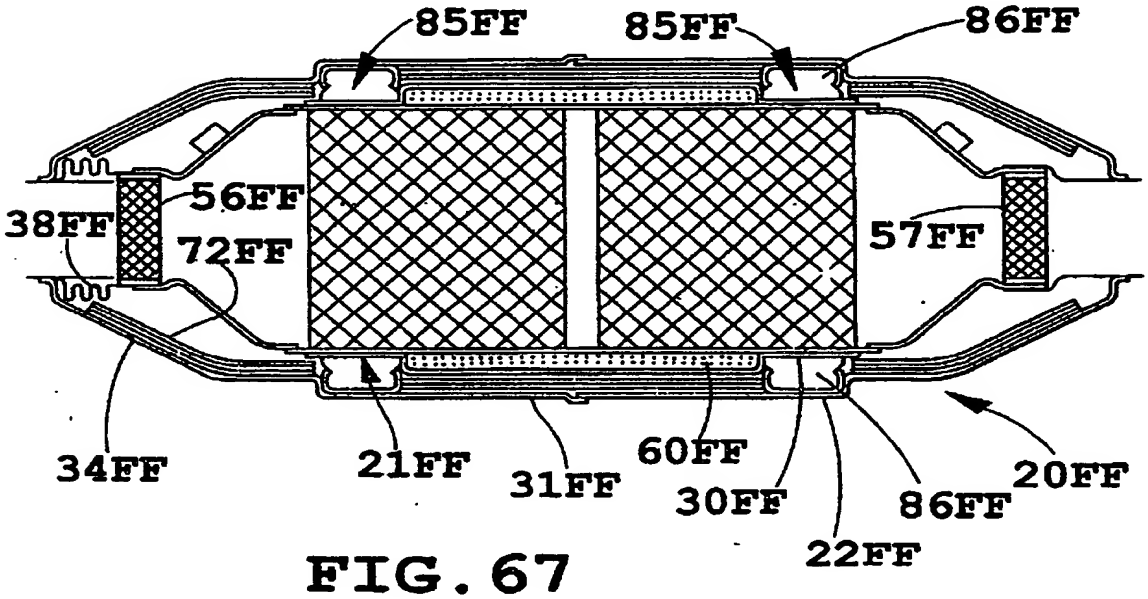

FIG. 67

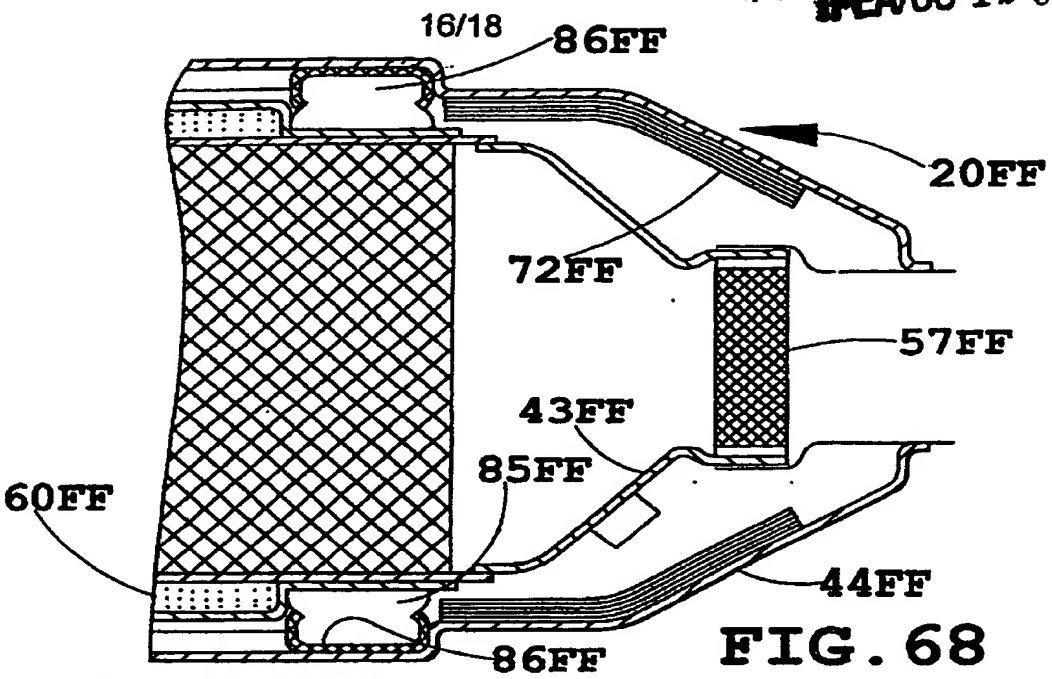

FIG. 68

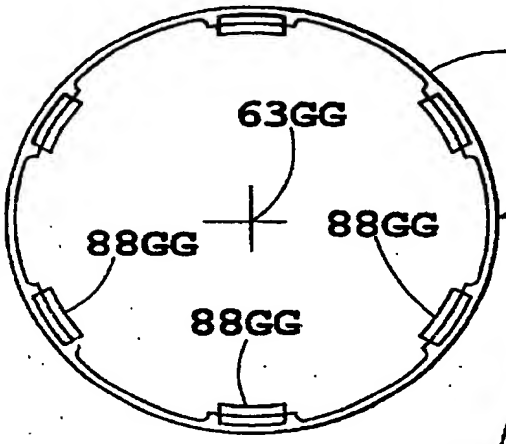

FIG. 69

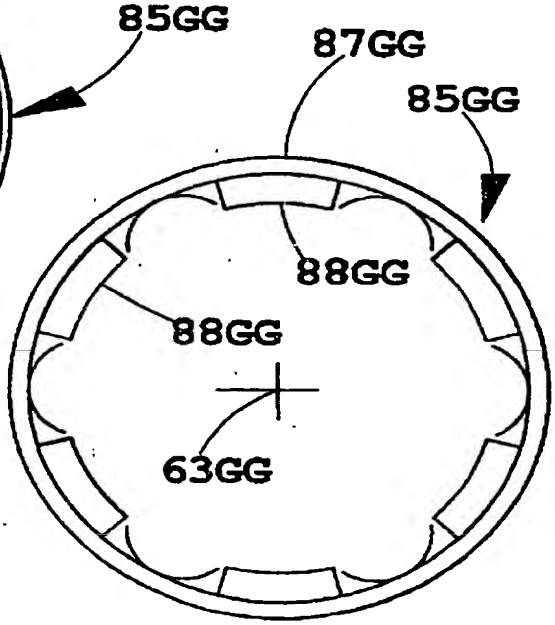

FIG. 70

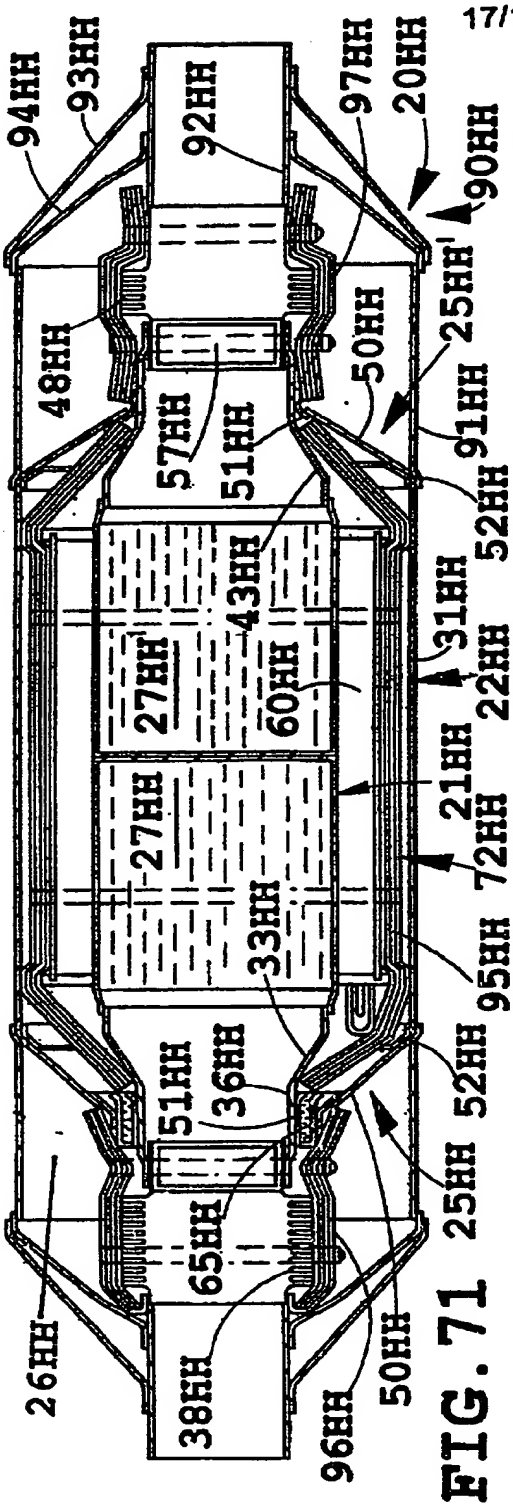

FIG. 71

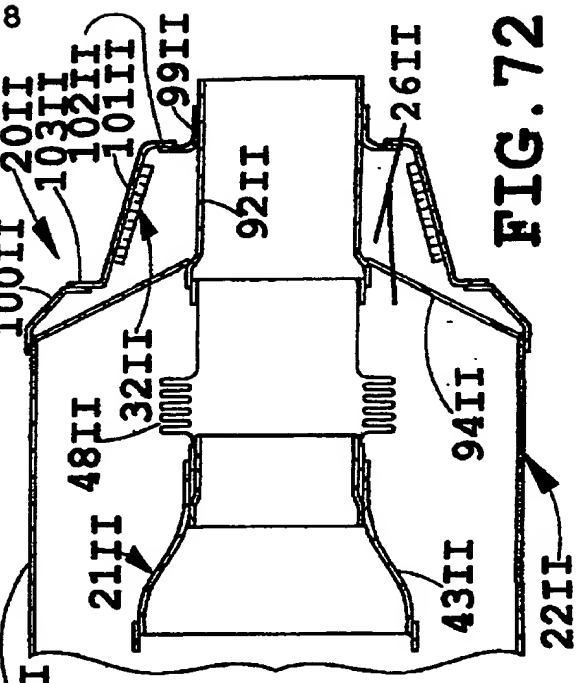

FIG. 72

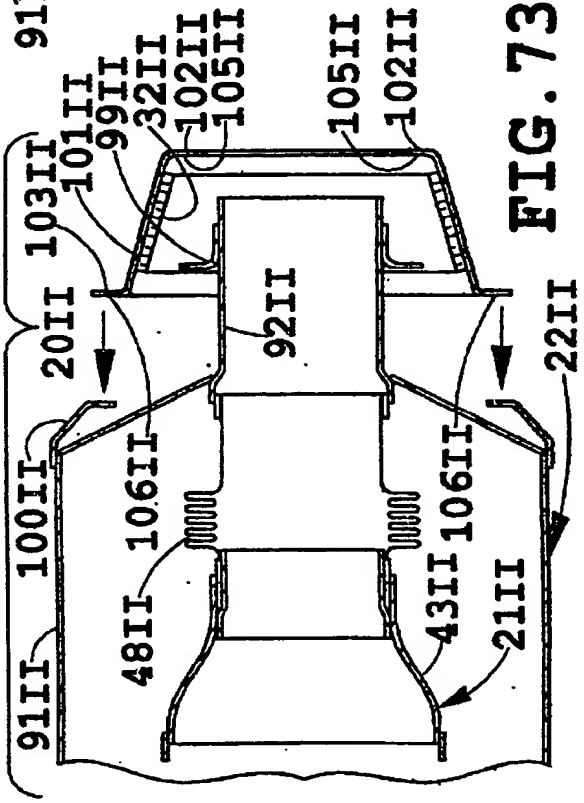

FIG. 73

PCT/US 00/01499
IPEA/US 12 JAN 2001

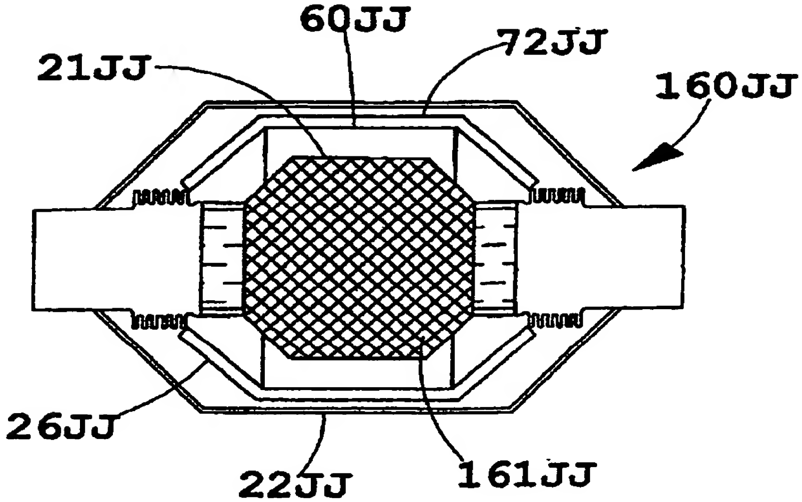

FIG. 74

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